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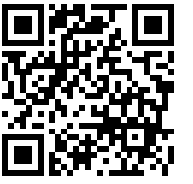

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*LIFE OF LORD KITCHENER. BY SIR GEORGE ARTHUR.**

By COLONEL E. M. LLOYD, LATE R.E.

SIR George Arthur has undertaken a difficult task, and has done it remarkably well. The forty-five years of Kitchener's service as a soldier were so full of incident, he was so largely engaged in the solution of intricate problems of various kinds, that his biographer has to make room for a bewildering mass of detail, and the personality of the man runs risk of being swamped by the record of his deeds. Also the last phase of his life, his part in the Great War, overshadows everything else and makes it no easy matter to preserve true perspective. But Sir George has steered his course safely between these rocks and shoals. He has the advantage of intimate friendship, and has succeeded in giving a clear, well-proportioned account of Kitchener's work and a life-like portrait of the man.

He was born on Midsummer Day, 1850. He was of Suffolk stock, though he happened to be born in Ireland. He was educated at home except for two years' schooling in France and Switzerland, and a year and a half with the well-known crammer, Frost. His father wished him to join the cavalry, but he was bent on becoming an officer of Royal Engineers. As a cadet at Woolwich he was not remarkable. He was a lanky youth, rather backward though a hard worker; but he had a knowledge of French and German, and was a good rider. He did not care for games and made few friends. He obtained his commission on the 4th January, 1871, being last but one of his batch. At the end of that month he made an attempt to see active service under Chanzy; but the fighting was over by that time, and exposure at Laval brought on an attack of pneumonia, from which he was slow to recover.

Among his few friends at Woolwich was Claude R. Conder, who was put in charge of the Survey of Western Palestine in 1872. By his invitation Kitchener joined him two years afterwards, and was engaged on this work for the next four years, being latterly in charge of the Survey. It was a task of danger as well as difficulty, and his health as well as Conder's suffered under the strain. When the map was finished the Committee of the Exploration Fund recorded their thanks to him, not only for the skill and devotion displayed, but for having kept his expenses below the estimate. In the autumn

* 3 Vols. (Macmillan). Price £2 12s. 6d.

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of 1878 he was charged with the Survey of Cyprus, and here he showed independence of character. He proposed to start with a triangulation, but the High Commissioner, Sir Garnet Wolseley, would not have it. The map was to be made of village surveys pieced together. The R.E. subaltern appealed to the Foreign Office, and the triangulation was approved; but the execution of the survey was suspended as long as Wolseley remained in Cyprus.

At the beginning of 1883 Kitchener went to Egypt as second-in-command of the cavalry of the new army which Sir Evelyn Wood was raising. Up to this time his health had not been good, but the climate of Egypt worked a transformation; food and sleep became matters of indifference to him, and his physique responded to the severest calls upon it. In 1884 Sir Samuel Baker wrote of him to Gordon as "one of the *few very superior* British officers, with a cool and good head and a hard constitution, combined with untiring energy." Kitchener's report on the Sudan when he was sent up the Nile to Debbeh in April, 1885, goes to justify Baker's opinion of him. His work in Egypt during the next twelve years made a similar impression on Lord Cromer and Lord Salisbury, so that the latter insisted that he should not be superseded in the command of the Expedition for the recovery of Khartoum. There seemed some likelihood that a senior officer might be appointed on account of the large number of British troops employed in the last stage.

The admirable organization of the Expedition and the skill with which it was carried out raised his reputation greatly, the more so because of the general eagerness to see the slur of 1885 wiped away. The tact which he showed at Fashoda, and the breadth of view with which he dealt with Soudanese problems threw fresh light on his capacity.

It was Lord Salisbury who decided, when Lord Roberts was sent to South Africa, that Kitchener should accompany him as Chief of the Staff. His functions hardly corresponded to his title. He was rather a sort of second-in-command, given special tasks to execute, and detached from time to time to act as Roberts' representative. Eight years before, Roberts had expressed the opinion that a Chief of Staff in the German sense was not well suited to British conditions:—"I doubt whether any really competent general or commander-in-chief would contentedly acquiesce in the dissociation of command and responsibility which the German procedure necessarily entails." Friction, he thought, would be almost sure to arise "unless the commander-in-chief were one of those easy-going soft natures which ought never to be placed in such a high position."* The part played by Berthier under Napoleon was, of course, very different, but would not have suited

* *The Brain of an Army*, by Spenser Wilkinson, second edition, pp.13-15.

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Kitchener or turned his energy to account. As it was, the happiest relations prevailed between the two men. After taking over the command in December, 1900, Kitchener wrote to Brodrick :—" We have never had, during the most anxious and difficult times, a single moment of unpleasantness," and Roberts told the Queen on his return to England " of Kitchener's self-suppression, his eagerness to undertake the hardest and most difficult tasks, his scorn of notoriety, and his personal loyalty."

Paardeberg was the most important instance in which Kitchener acted as Roberts' representative, and the result was disappointing. Sir George Arthur attributes this to the want of an adequate staff, and blames Roberts for having " omitted to provide his deputy with the means of exercising the authority which he delegated." But in his own version of the fight, written three years afterwards in India, Kitchener makes no reference to this deficiency ; he maintains that he took the right course and accepts full responsibility. Like everyone else, he had to learn by experience how to fight Boers.

A slight tendency to the disparagement of Roberts is noticeable elsewhere in these volumes, and exaggerated stress is laid on the mischief done by Roberts' saying that the war was practically over when he handed over the command. It showed a want of foresight, but guerrilla warfare defies prediction. Two months afterwards Kitchener, after his meeting with Botha, was sanguine that peace was within reach. A year and a half was needed to bring it about, and it was attained then by Kitchener's boldness of conception in the use of barbed wire, blockhouses and drives, and by his skill and patience in negotiation. He was fortunate in having the hearty support of Mr. Brodrick, the War Minister, and he reaped further advantage from their cordial relations when he was commanding in India and Mr. Brodrick was at the India Office.

Kitchener's seven years in India were in their way as strenuous as the seven preceding years in Africa. In the reorganization of the army with a view to war, the improvement of the condition of the soldier, and the abolition of the dual control he had to encounter strong opposition. On the principle of *divide et impera*, as we are told, the Viceroy fought hard for the Military Member of Council. The present Lord Salisbury, in his interesting preface, says that Kitchener " had no skill in argument, and no respect for it." That may be so as regards the mere thrust and parry of verbal fence. But he could hardly have carried his reforms if he had been without skill in the statement of his case. Those who disapprove of the changes he brought about practically pay a high tribute to his powers of persuasion.

At the end of 1905 Lord Minto succeeded Lord Curzon as Viceroy, and Mr. Morley succeeded Mr. Brodrick at the India Office. The latter change brought Kitchener up against demands for retrench-

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ment and other Liberal shibboleths, and some of his reforms had to be postponed; but on the whole the two men worked well together. Lord Minto was a most friendly go-between. Soon after his arrival he wrote:—"I find him (Kitchener) very broad-minded, very ready to see both sides of a question, and perfectly easy to deal with, whilst his minutes on the questions we have had to consider since I have been here have been much the ablest and most moderate I have had before me." Nearly three years later, in another letter to Morley, Minto said:—"The more I see of him, the more I admire his ability, excellent judgment, and level-headedness. He would do splendidly in any position, and is a valuable asset which the country cannot afford to see put on the shelf. He is a curious personality, not attractive in manner, but has a kind heart buried away somewhere, and his inner tastes are much more artistic than military." But in spite of this praise and of strong outside pressure Lord Morley would not gratify Kitchener's ardent wish that he should go back to India as Viceroy. The unlikeness of type and ideals was too deep.

Perhaps it was the same sense of incompatibility that made the Prime Minister hestitate to employ Kitchener at the outbreak of war in 1914, until the public demand became insistent. He had already started for Egypt when he was recalled from Dover to become Secretary of State for War. It was his first employment in the War Office, for Mr. Brodrick had tried in vain to persuade him to serve on the Head Quarter Staff. He had to familiarize himself with its methods when the machine was dislocated by the tremendous strain to which it was suddenly exposed, and by the loss of many of its best officers. He had to feed the old army with men and stores, and to create a new one. Fortunately, his sound judgment and largeness of conception enabled him to take a true measure of the necessities of the case, and escape the easy optimism which prevailed. As he wrote to Sir John French:—"Believe me, had I been consulted on military matters during the last three years, I would have done everything in my power to prevent the present state of affairs in which this country finds itself." There was something of irony in the fact that his sharpest critic was the man who had been Chief of the Staff till within a few months of the war.

Sir George Arthur rightly avoids controversy, but the materials he gives enable his readers to form their own opinion on Lord French's complaints in connection with Kitchener's journey to Paris at the end of August, and the shortage of munitions in the spring of 1915. The depression caused by the failure at Festubert, and by an order to send some of his reserve ammunition to Gallipoli (to save time), led Sir John French to carry his griefs to the Press and the leaders of the Opposition; yet only a week before he had written to Kitchener "the ammunition will be all right."

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These complaints might lead one to infer that relations were strained between the War Minister and the Commander-in-Chief, but this does not seem to have been the case. Their meetings were frequent and friendly, and nothing could be warmer than Sir J. French's language towards the end of 1914 :—" We all feel here that we are absolutely safe in your hands, and we have the most unbounded trust in your support and help. I repeat what I have said before, 'Thank God you are there,' and I mean it. You are the one man I have always looked up to and believed in as a soldier, and I rejoice to be serving under you again." Kitchener for his part had written to Brodrick at the end of the Boer War :—" French is the most thoroughly loyal, energetic soldier I have, and all under him are devoted to him—not because he is lenient, but because they admire his soldier-like qualities."

On one point, it is true, they did not see eye to eye : French was a " Westerner " opposed to side shows ; Kitchener was allured by the great possibilities of the Dardanelles enterprise. The East had a large place in his mind, and he was equally alive to what was to be gained by success, and to the risks we should incur by failure. When the subject was under discussion in January, 1915, he had no troops to spare for it, and he held that a purely naval attack on land forts was not likely to succeed. He was assured, however, that what had been done at Liège might be done in the Dardanelles by vessels like the *Queen Elizabeth*. Bowing to naval opinion he gave his concurrence, and was soon led on to promise troops enough to supplement and complete the work done by the Navy. But before the troops could arrive the ships made their attack and failed ; and a landing by surprise, which might have succeeded, was no longer possible.

The painful story of the next nine months is told here very fully by extracts from the letters of Sir Ian Hamilton and Sir W. Birdwood. When the demands for men and yet more men could not be met then came the question of evacuation. Sir I. Hamilton estimated that half the force might be lost, and Kitchener told Mr. Asquith :— " I pace my room at night, and see the boats fired at and capsizing, and the drowning men." Happily it was accomplished almost without loss. Kitchener was sent out to judge the situation on the spot, and he was most anxious that the troops withdrawn should be landed at Alexandretta, to counteract the loss of prestige and to guard Egypt. He was not allowed to have his way. The Turco-German attack on Egypt which he foresaw took place in the spring of 1916, but proved a failure.

At the end of 1915 Sir Douglas Haig succeeded Sir John French as Commander-in-Chief in France, and Sir William Robertson came to the War Office as Chief of the Imperial General Staff. It was laid down that he should be the medium for submitting reports and

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proposals to the War Council and for notifying its decisions. There was a general impression that this meant a clipping of Kitchener's wings; but Robertson was the man of his choice, and he welcomed the change, both because it would lessen his excessive burden of work, and because the new Chief of the Staff would be "a most valuable buffer against plans of campaign emanating from individual ministers who might exercise highly trained faculties of persuasive rhetoric to commend to the authorities the children of their too fecund imaginations."

After all, Kitchener's great work in the war was not as a strategist, but as the creator of the new armies, and one could wish that his biographer had given fuller details of the way in which this stupendous task was carried out. It was as an administrator rather than as a soldier that he showed his greatness. He does not seem to have taken much interest in the art of war, either on its tactical or its technical side, apart from the particular problems that he had to solve.

Of the tragedy of the *Hampshire* Sir George Arthur says little, but he states—not as a matter of surmise, that "by an unhappy error of judgment an unswept channel was chosen for the passage of the cruiser; and Kitchener—the secret of whose journey had been betrayed—was to fall into the machinations of England's enemies, and to die swiftly at their hands."

Some lines written of an Elizabethan worthy were happily applied to him:—

"The waves became his winding-sheet,
The waters were his tomb;
But for his fame on earth and sea
Was not sufficient room."

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STRUCTURAL STEELS.

FROM A LECTURE GIVEN AT THE S.M.E. BY MR. HARRY BREARLEY.

ONE of the questions frequently put to Engineers, military or otherwise, is whether a particular structure will bear a given stress. To answer the question, consideration must be given to the design of the structure and the " nature " of the material of which it consists. These considerations modified to some extent by experience, enable the capable engineer to approve of this or disapprove of that structure with a certainty which is justified by results.

As steel is one of the materials which enters largely into your various structures, it is proposed that we should say something about its " nature " in order that you may select (or reject) it with good reason to create your design and fulfil your purposes. The basis of selection which ought to appeal most strongly and directly to engineers is that relating to the internal design of the material itself and the nature of the constituent parts of the design. If from this standpoint we can explain the known properties of structural steels, and develop those properties less well known, we may perchance not only impart information, but also provide an instrument of thought whereby the choice of the right material will be a simple matter. Closely bound up with this aspect of the subject, once we know the interior design of our material, is the prospect of modifying it to suit our varied purposes. And if we are so far interested there should be no difficulty in devising tests, other than those which belong to the wrought iron age, to determine and control the properties of steel and predict its likely behaviour under given circumstances. Such an ambitious programme cannot be covered in a single lecture, but unless I fail in my purpose we shall want to carry the subject further along these lines and test it by experiment at many points.

Like all solid metals, steel of all kinds is crystalline. In passing from the liquid to the solid state, the crystals grow from the cooling surfaces or form freely in the mother liquor and remain suspended there or fall downwards. When cast at a temperature much above its melting point, the solid steel consists almost entirely of crystals growing from the cooling surfaces as in *Fig.* 1. When cast at lower temperatures, the interior portion consists of crystals which have formed freely and wandered in unpredictable ways to different parts of the ingot as in *Fig.* 2. These crystalline characteristics,

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impressed on the material as it freezes, are never entirely lost however much the material may be forged or rolled, and the influence they exert on the properties of steel castings is, as you may imagine, of first-rate importance. We must, however, ignore these differences, and many others due to methods of melting steel and casting ingots, in favour of our immediate subject.

The forging and rolling of steel may alter the relative shape of its crystals and decrease their size, but it does not destroy them. If we imagine that pure iron has been melted and cast and forged into a bar, a section through such a bar, after polishing, etching, and suitably magnifying, would present the appearance of *Fig.* 3. The cell-like enclosures are merely outlines of the sectioned crystals which have been made visible by appropriate etching.

The main distinction between iron and steel is the presence in the latter of greater or lesser amounts of carbon. The carbon may be added by a cementation process as in the manufacture of shear steel and the common production of case-hardened objects, or it may be added by the simple expedient of melting together wrought iron and charcoal. By whatever means the carbon is added, and quite independent of the process by which the steel is made, we find always on the polished and etched section a greater or less part of it occupied by dark areas as in *Fig.* 4; and the physical effect of these dark areas as they increase in size or number, is to make steels containing them harder and harder.

If a specimen of steel instead of containing ·15% carbon as in *Fig.* 4 should contain ·30% carbon as in *Fig.* 5 the dark parts are proportionately increased in area, as you will see by making a comparison. With ·45% carbon (*Fig.* 6) these areas are still further increased and you may note that the light and dark parts occupy approximately equal areas. This continues in the same way until at ·90% carbon, the entire field consists of dark etching areas.

These dark or pearlite areas are not themselves structureless. At higher magnification they are seen to consist of apparently light and dark laminae (*Fig.* 7) which have been recognised as alternating plates of practically pure iron and iron carbide. If by the time ·90% carbon has been added all the available iron has been used to form the pearlite laminae, then all further additions of carbon may form iron carbide, but it must exist in the steel in some other form. This it actually does, and we find that it occurs usually as carbide envelopes about the crystalline grains (*Fig.* 8), or as comparatively massive plates lying parallel to the axes of the crystalline grains (*Fig.* 9) or in both forms (*Fig.* 10).

From this brief explanatory *résumé* it appears that the introduction of carbon into iron to produce steel modifies its properties by forming within it a new and distinctly separate substance called carbide of iron. This carbide is very hard and consequently brittle. It is

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very finely dispersed and intimately mixed with the iron so long as the amount of carbon does not exceed one per cent. but any excess exists in a comparatively coarse state in positions favourable to the starting and propagation of cracks. From these considerations the hardness of steel will obviously increase as the pearlite grains occupy a larger portion of the material. It is equally obvious that the toughness will decrease as the ferrite grains, composed of soft flexib'e iron, become less. But the toughness may be considerable so long as each small plate of carbide is cushioned between two plates of soft iron, *i.e.* until the amount of carbon approaches one per cent. When, however, the carbide must form comparatively large plates, or brittle envelopes separating each grain from its neighbour, the intergranular strength becomes less and the mass as a whole exhibits signs of brittleness.

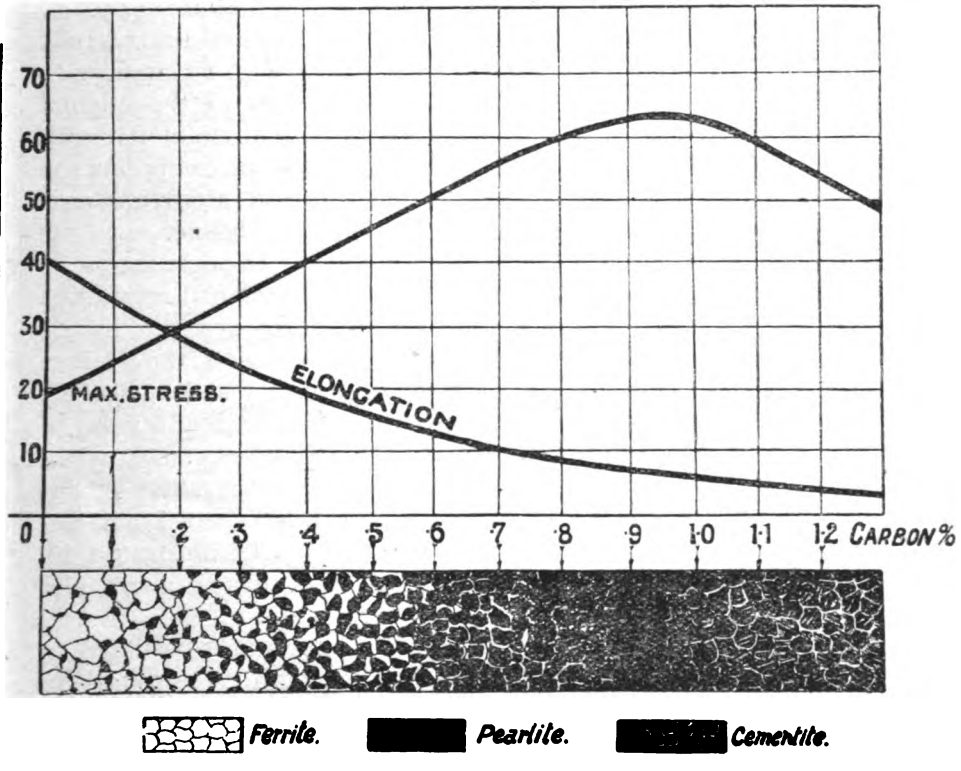

FIG. 11.

These structural facts and the correlated mechanical properties, which are in line with general experience, may be represented graphically as in *Fig.* 11 Such a picture summarizes practically all we knew about the properties of steel up to 20—30 years ago. Tool steels were hardened, mainly to improve their cutting

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properties, and commoner articles, such as springs, were hardened and tempered for special purposes, but the heat-treatment of structural steels with the idea of improving their general properties was hardly dreamed of.

The addition of special alloys to steel in order to improve its value as structural material, was practised some years before the usefulness of heat-treatment was realised. Logically, however, the use of alloys should have come afterwards because we cannot appreciate the meaning and value of alloy steels until we understand what is meant by heat-treatment.

As a crude but striking example of the meaning of heat-treatment, we may take a piece of mild steel in the form of a casting or overheated forging. Structurally it consists of coarse crystalline grains built up of ferrite or pearlite as seen in *Fig.* 12. On gradually raising the temperature of this material and quenching specimens at suitable stages, nothing appears to happen until at about 750° C. a quenched strip instead of bending breaks off short on being struck with a hammer. The general outline structure (*Fig.* 13) appears to be unaltered, but if we compare the dark areas of the original material (*Fig.* 14) at larger magnifications, with those of the strip quenched at 750° C. (*Fig.* 15) we see that the laminae composing the pearlite have inter-diffused. These inter-diffused areas are now quite hard, although the white areas are as soft as before.

At any higher temperature the transformed areas begin to spread outwards, and at 780° C. though the outline of the original crystalline grains is visible (*Fig.* 16) it is obviously being over-run by its neighbour as though it were a living thing. At 800° C. the original crystal outline is barely distinguishable (*Fig.* 17) and at 850° C. we have neither light nor dark constituents but a uniform mass of crystals (*Fig.* 18) of much smaller size than those we started with. When the inter-diffusion is complete the large crystalline grains break up into smaller ones. Why this refining occurs I am not competent to explain but the extent of it may be illustrated by comparing the original grain size with the refined grain size (*Fig.* 19).

If the specimen is quenched from this inter-diffused condition, we call the process hardening. If the specimen is allowed to cool in the air we call it normalising ; and if the cooling is purposely made very slow we call it annealing. The advantage of the operation lies in the fact that the larger crystals have been replaced by smaller ones. These smaller crystals may be trapped in the hard condition ; or during slow cooling the transformations will take place in a reversed order and the material becomes soft again as it was to begin with, but its structure in the slowly cooled condition is entirely changed as may be seen by comparing the two photos in *Fig.* 20.

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The effect of a normalising operation on the mechanical properties of an overheated steel is illustrated by *Fig.* 21. The maximum stress, as might be expected, remains practically unaltered and so does the elongation %. The yield point rises because the crystals are smaller, and therefore more effectively reinforce the strength of the so t ferrite particles which would of course be the first to yield under stress. But the most striking effect is shown by the increased impact figure which reaches a maximum at a temperature corresponding to complete inter-diffusion of the micro-constituents and thereafter falls because the higher temperature begins to enlarge the size of the refined crystals. The first effect, therefore, of appropriate heat-treatment, is to replace coarser crystals by finer ones, and this in itself is a mechanical advantage.

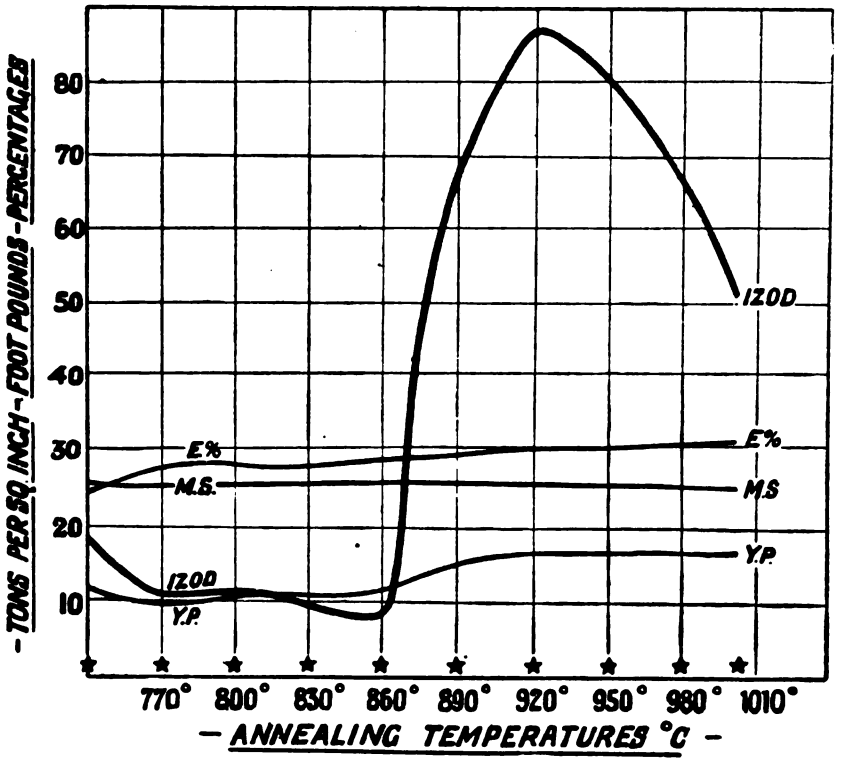

FIG. 21.

If the temperature of our specimen is reduced quickly, by cooling in some quenching medium like water, we preserve the material more or less in the inter-diffused condition, and if is also hard. Both these features are advantages. The first because we are now dealing with a more homogeneous substance, and can therefore more reliably depend on its behaviour under diverse conditions of stress, and the

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second because we can barter the hardness, or as much of it as is not wanted, for increased toughness.

Generally speaking, the extent to which the toughness of a material can be improved by heat-treatment, depends on the extent to which it can be hardened by quenching. As, however, the heated steel, whose constituents are in the diffused state, passes again into its normal soft condition at a certain rate, it cannot be kept in the inter-diffused condition and be made hard unless quenching cools it at a still greater rate. Thus a pure carbon steel bar, say, one inch in diameter, might be hardened in water, but it could not be made very hard by quenching in oil. If we add also, say, one per cent. of manganese, the bar would be practically as hard when quenched in oil as when quenched in water, the reason being that the added manganese delays the "rate" at which the diffused constituents re-appear as separate substances. Any element, therefore, which, added to steel, delays the rate of reappearance of the diffused constituents enables the steel to be hardened by cooling in oil, or in extreme cases, by cooling in air. Also for the same reason such added elements enable larger masses of steel to be hardened almost as completely in the centre as on the outside.

This brings us at once to a consideration of alloy steels. If the added alloy confers additional toughness, and at the same time permits us to induce great hardness in considerable masses of steel, so much the better. The increased hardness, however, is the feature on which we must rely because such hardness can be bartered for a degree of toughness which cannot be purchased, in association with other desirable mechanical properties, in any other way.

Let us see what this means to the Engineer who wants to use weight sparingly, and at the same time produce strong structures subject, may be, to severe shocks. A piece of ·3% carbon steel, say about one inch in diameter, when quenched in water would have a tensile strength of about 50 tons. A piece of steel containing 3% nickel, but in all other respects identical, would have a tensile strength of about 100 tons. If we temper the nickel steel we can reduce its tensile strength to 50 tons, and in exchange for the lost hardness we get a great deal of toughness. By comparing the ductility and toughness of two steels having the same tensile strength, or the hardness of two steels having the same ductility and toughness figures, we may fairly choose which of them is the better for any given purpose. The mechanical properties of the two steels before us were found to be :—

Composition.					Mechanical Properties.				Izod
C.	Si.	Mn.	Nickel.		Y.P.	M.S.	E%	RA%	Impact Foot pounds.
·33	·15	·63	*Nil*	....	?	52·8	16·0	43·2	10 & 11
·33	·13	·63	3·28	....	43·2	52·9	25·0	64·9	100 & 104

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Suppose now we consider such a steel as the one used during the war in large quantities in the manufacture of crank-shafts and connecting rods for aero engines. As small bars it would harden when cooled in air, and in fairly large bars it would harden when cooled in oil or water, up to a tensile strength of 100/120 tons. By tempering hardened bars at gradually increasing temperatures, we lose hardness but gain other valuable properties. If the results of tests made on the bars reheated to the various temperatures are tabulated or plotted (*Fig.* 22), we have before us a picture showing a wide range of mechanical properties which can be induced at will in the same kind of steel in order to serve diverse purposes.

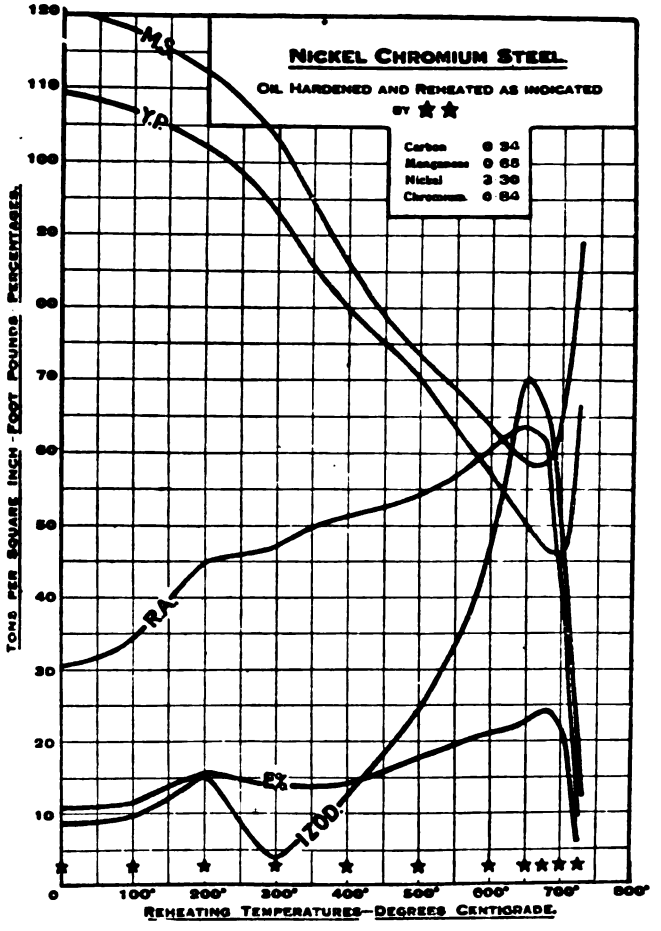

FIG. 22.

For many years a few steelmaking firms have been testing all known kinds of steel and arranging the tabulated results in the order of chemical composition just as a dictionary is arranged in

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alphabetical order. Such a collection of results which may be called a dictionary of mechanical properties, would, if available, be of great value to engineer designers. But from it all, two things stand out clearly. First, that alloy structural steels are bought to very poor purpose unless they are used in the heat-treated condition, and second, that ordinary carbon steels of not too great a mass—even common structural steels—may be advantageously heat-treated, and when so treated are often superior to alloy steels used in the forged or annealed condition. These statements ought to be supported by evidence, but although evidence in plenty is available, time is not.

One of the most useful constructional materials is wood. The varying hardness and toughness of wood is known intimately only to those who work with it, but everybody knows something about the grain in wood, and a novice who used wood in a stressed structure without regard to the direction of its grain would probably get into trouble sooner or later. The grain in forged or rolled steel is just as real as it is in wood but it is not so obvious. After boiling in dilute acid, a piece cut from a bar of mild steel will have an appearance something like *Fig.* 23 ; on one face is seen the length, and on the adjacent face the end of the grain is visible. Obviously, severely stressed material ought to be arranged with its grain most favourably disposed towards the direction of stress.

To obtain some quantitative idea of the influence exerted by the direction of grain on the mechanical properties of steel, an ingot was rolled into a flat bar. From this bar duplicate test pieces were cut at angles inclining variously to the length of the bar. The results of the tests are plotted in *Fig.* 24. Kindly note the elongation and reduction of area %, both fall rapidly when the pull on the tensile test piece is exerted at an inclination to the grain of greater than 40°; also that the impact figures are the most sensitive indication of the deteriorating effect of grain, as they fall continuously from nearly seventy foot-lbs. down to seventeen foot-lbs.

The notched bar impact test has been defined as a means of measuring the effort required to propagate an incipient crack across a given area of material. Personally, I think very highly of it and would accept its indications together with a Brinell hardness test, in preference to the results of the most elaborate tensile and bending tests. But, however right or wrong that view may be, there is no test so convenient or sensitive if we desire to study the influence of grain in steel. A gear blank may be cut from a round bar and if teeth are cut across its edge at right angles to the faces, such teeth are apt to shell off in service because the grain is least favourably disposed towards the stress. A blank made by hammering in the corners of a flat bar to produce a circular disc is not much better because the resistance of the teeth would vary from a maximum to a

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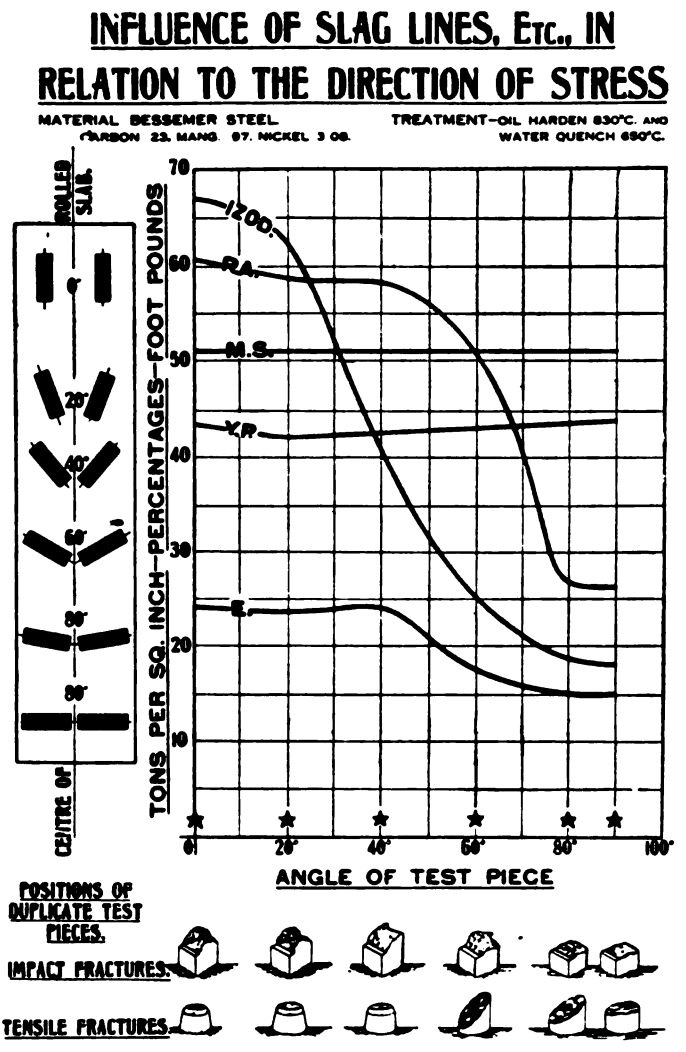

FIG. 24.

minimum according to their position (*Fig.* 25) and a gear is no stronger than its weakest teeth. The most satisfactory way of producing a gear blank is to up-end it from a bar of much smaller diameter.

By developing the grain, much can be discovered about the way in which an article has been forged. Six-throw crank-shafts for aero engines were produced during the war by forging and twisting the webs to the required angle, by gapping bars forged to a trifoil section and by drop stamping. The machined crank-shafts were alike in appearance, but they could be easily distinguished by examining the flow of the hot steel as shown by the grain (*see Figs.* 26, 27, and 28). Cranks-shafts of each kind were cut up into impact

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test pieces from which results closely following variations in the direction of the grain were obtained. Compare the grain structure of *Fig.* 28 with the impact results of *Fig.* 29.

I have been asked to say something about high speed steel. Unless you are willing to listen to another and entirely different lecture, it would be difficult to indicate anything more important or more objectionable in high speed steel than grain. If high speed steel in the toughest possible condition is broken along its length, the fracture has a reedy appearance. The explanation is simple. In the ingot state the crystalline grains are surrounded by brittle envelopes of complex carbides (*Fig.* 30). At forging temperatures these are attenuated but rarely destroyed by diffusion and consequently are elongated with the bar. In small bars the envelopes may appear to exist as parallel lines, but in either small or large bars the effect is similar. This explains why cracks in high speed turning tools are usually along the shaft ; why teeth in cutters shell off at the root ; and why high speed steel screwing dies are more popular than high speed steel taps.

If the fundamental structures have been clearly presented then in relation, neither to high speed steel nor the various forms of structural steel, is it necessary to emphasize the correlated physical properties ; they should speak for themselves to military engineers who are accustomed to estimating the strength and reliability of structures of a visible design built of known materials.

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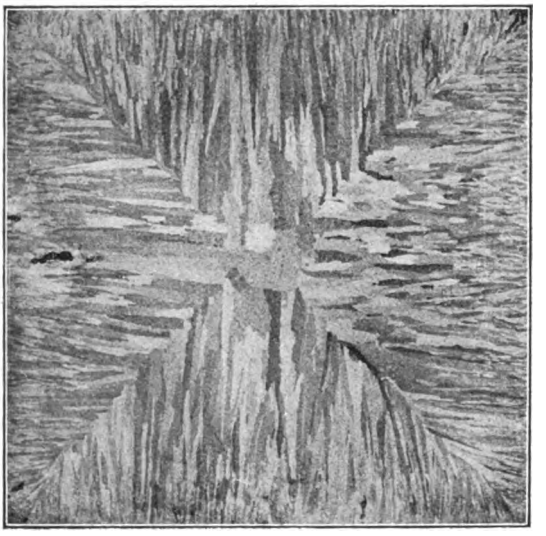
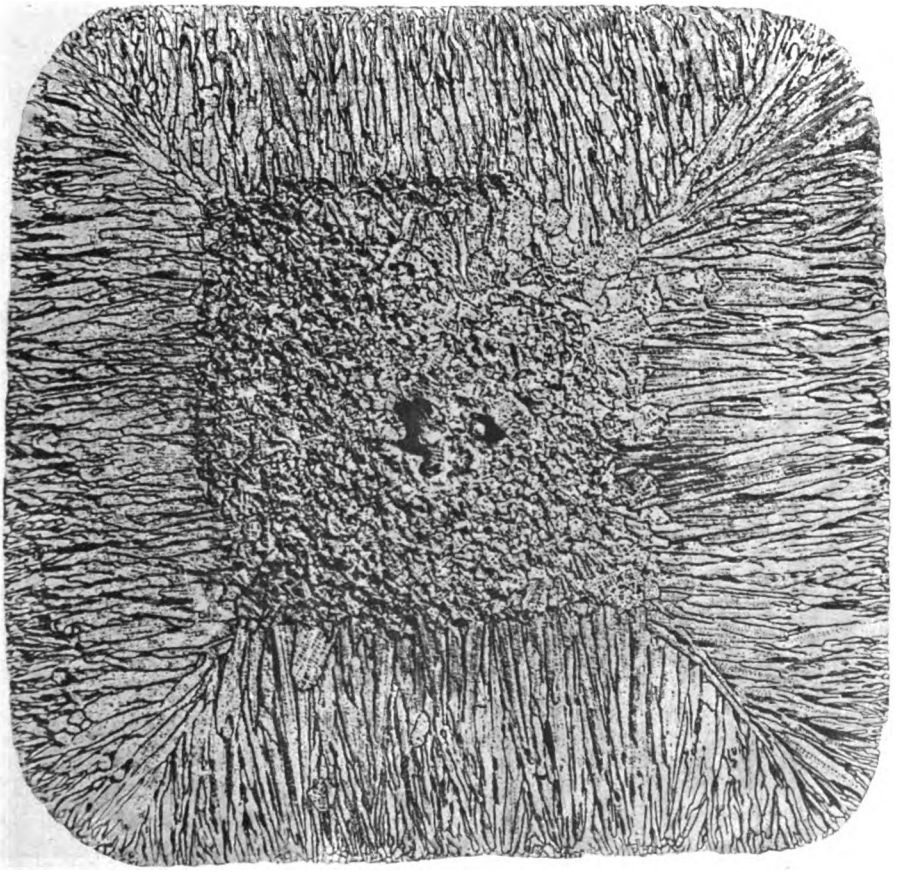


FIG. 1.



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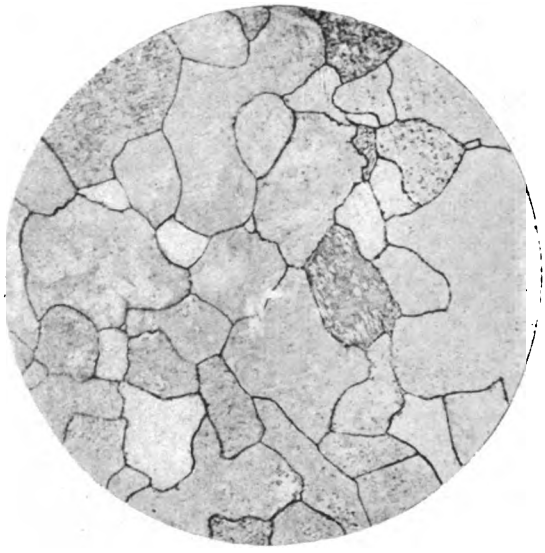

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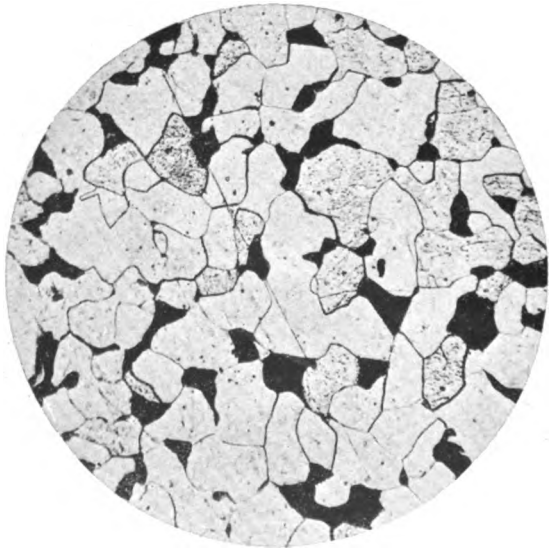

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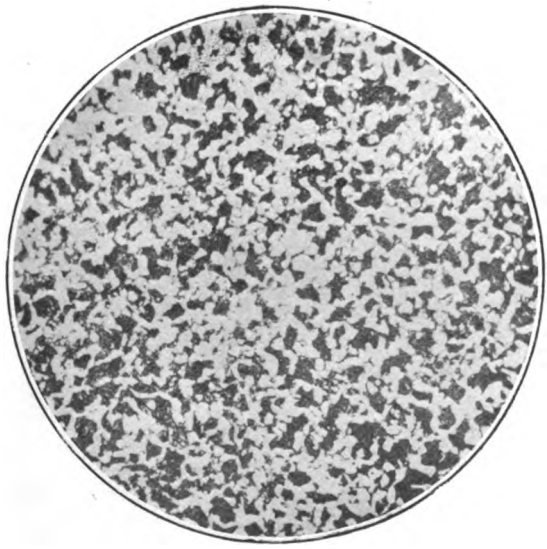

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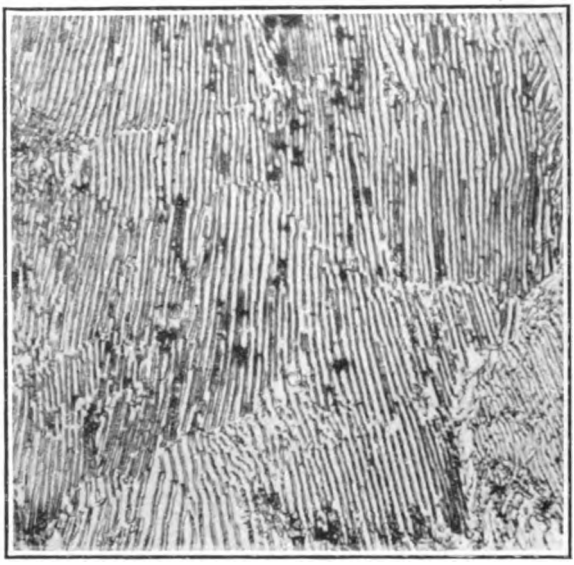

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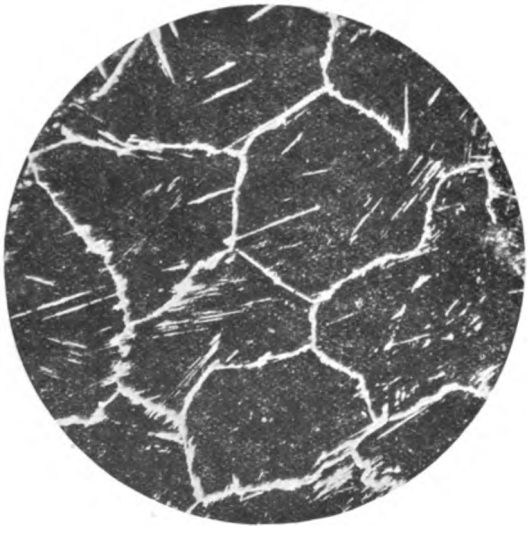

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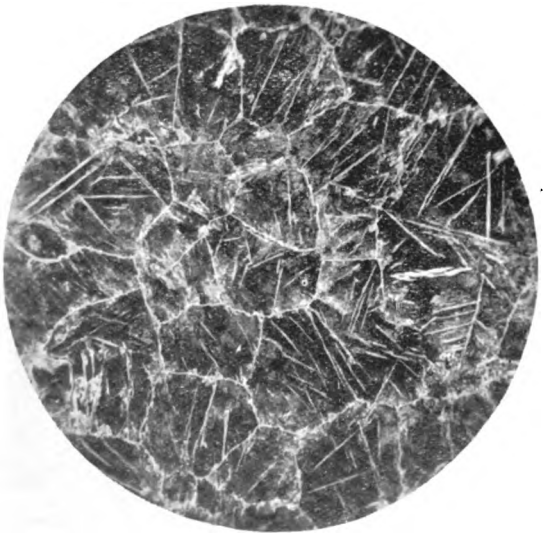

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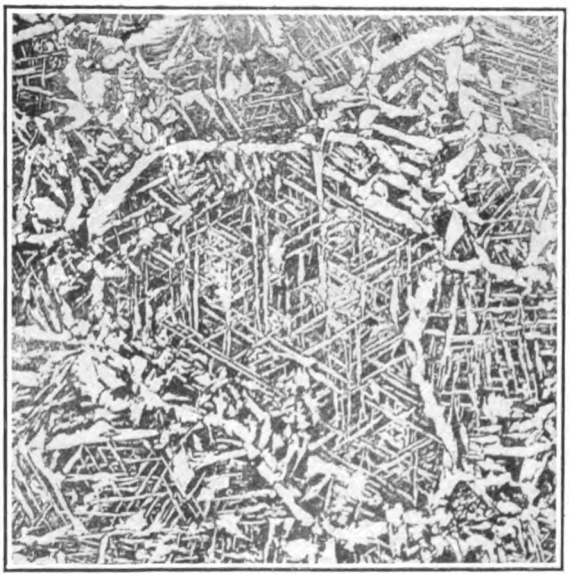

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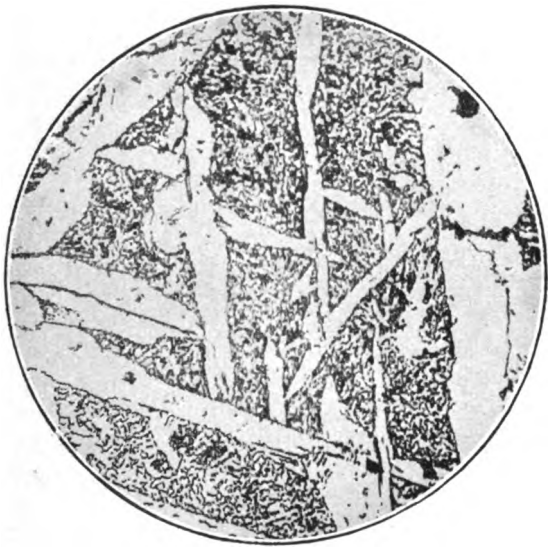

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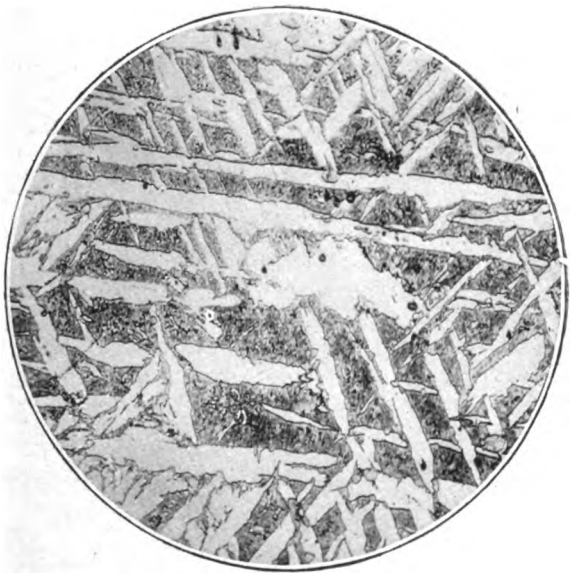

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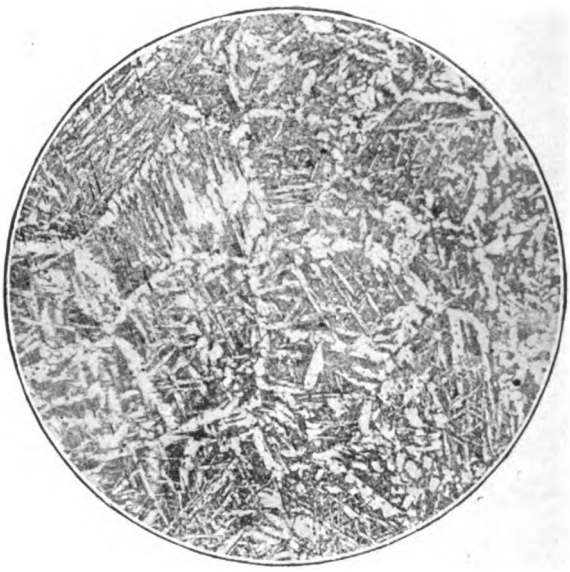

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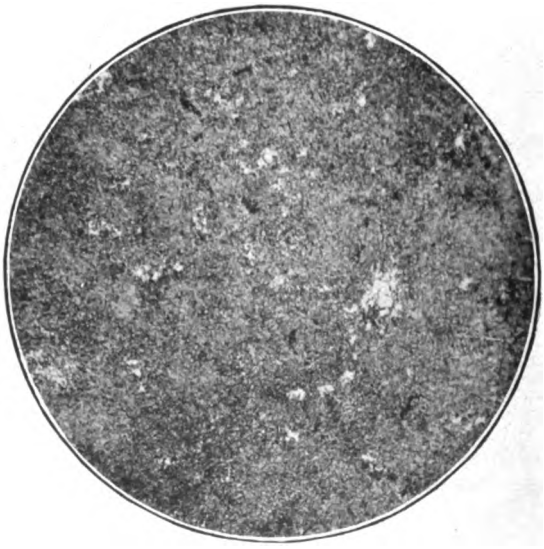

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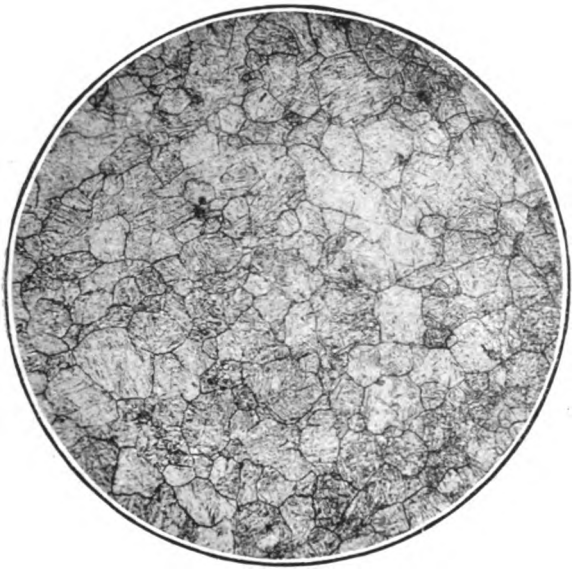

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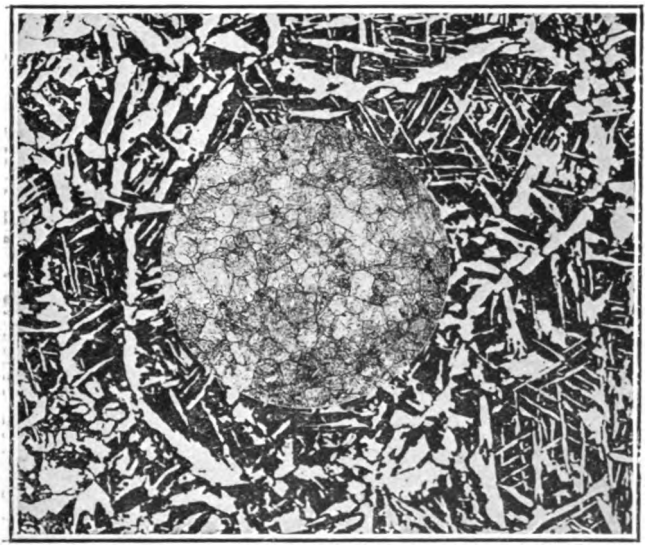

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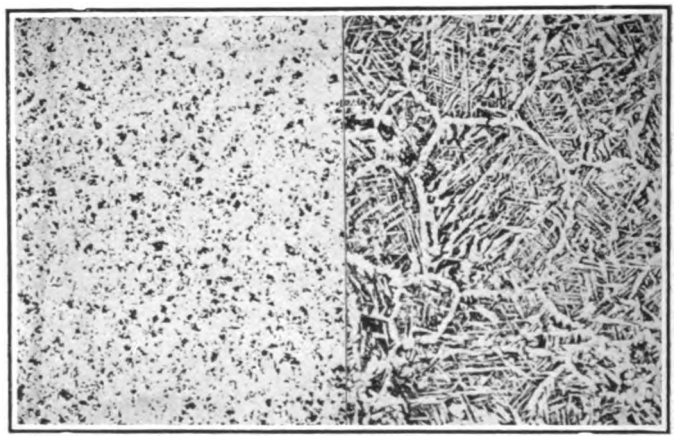

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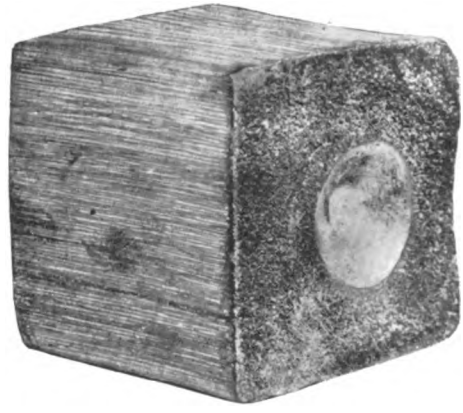

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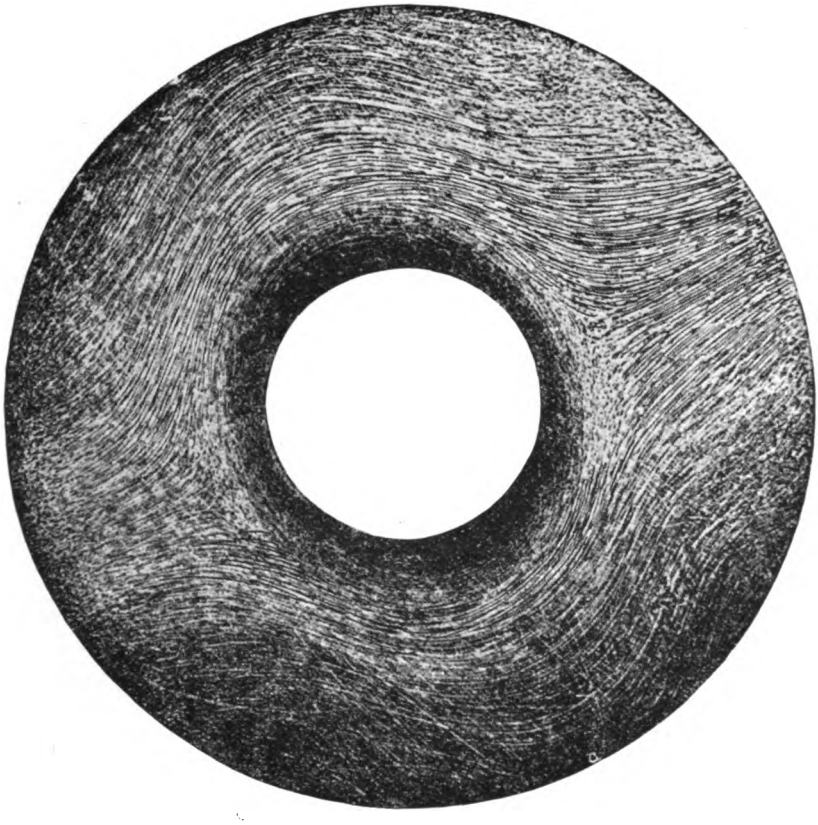

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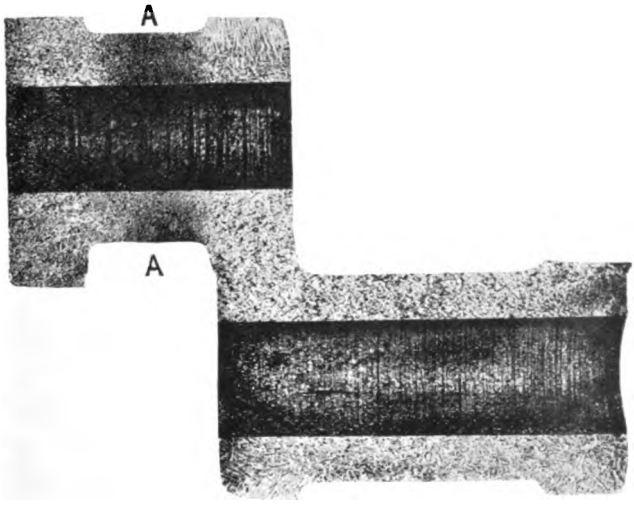

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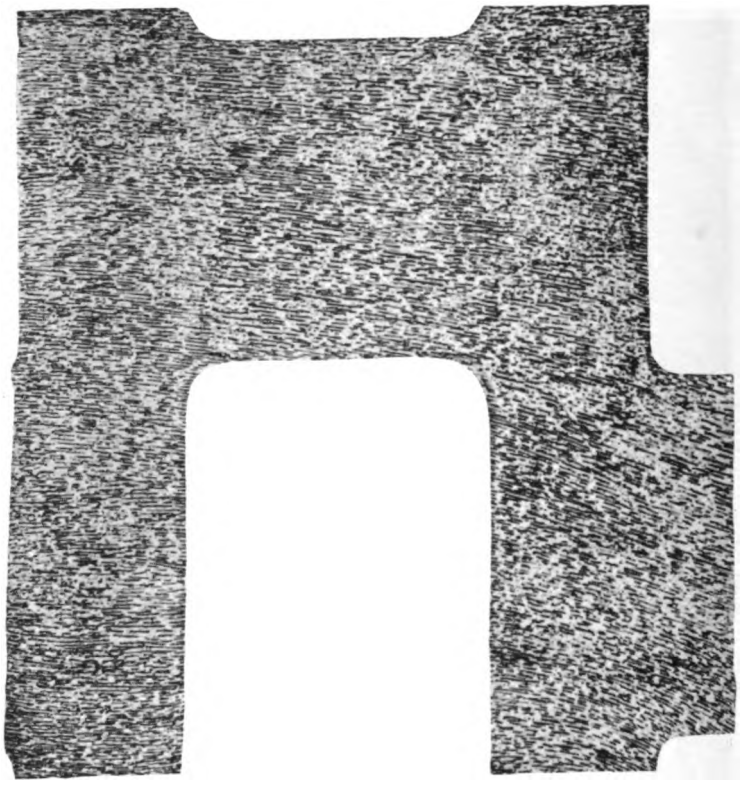

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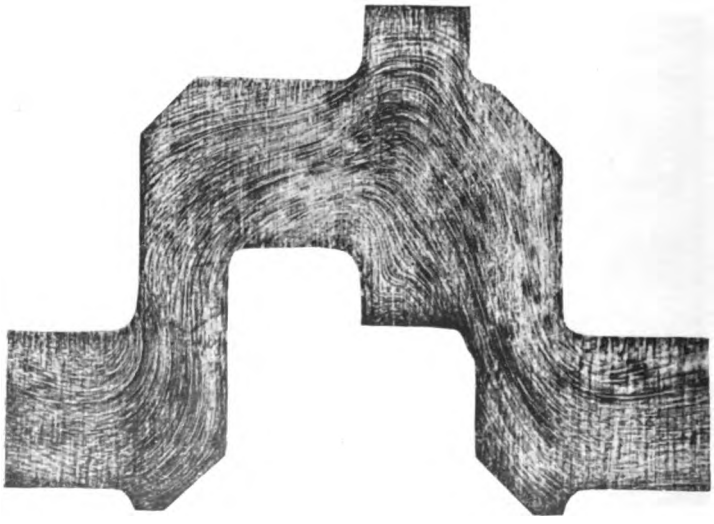

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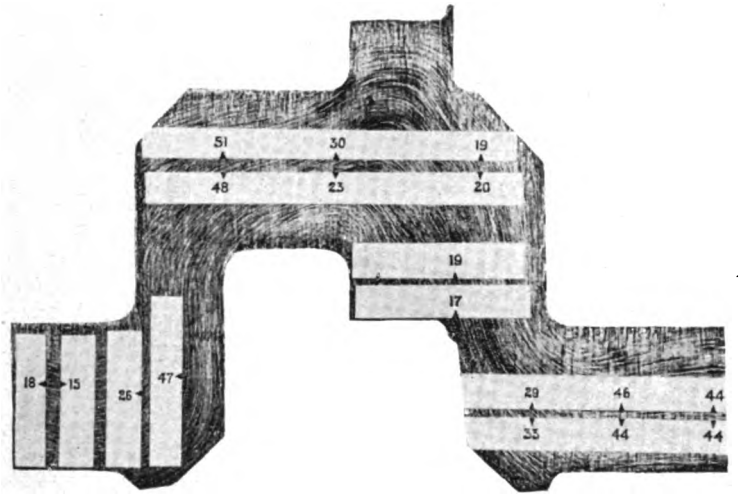

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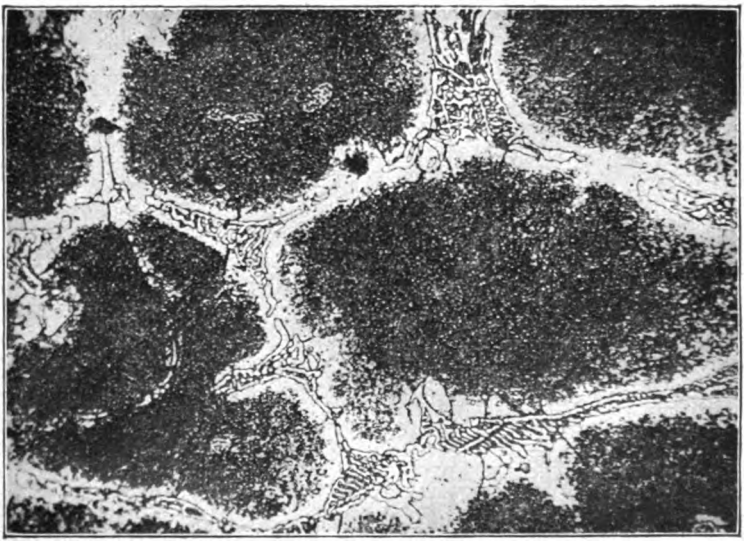

FIG. 30.

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SCIENCE AND THE NATION.

By COLONEL THE RIGHT HON. LORD SYDENHAM, G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., F.R.S. (late R.E.).

By the kind permission of the Executive Committee of the British Science Guild.

AT the Annual Meeting of the British Science Guild,* held on Tuesday, June 8th, Lord Sydenham delivered the following Presidential address :—

In a letter which I lately received from a distinguished American and a warm friend of this country, he says :—

> " To me the greatest problem of the hour is the strike, which I think a greater menace to the world than Kaiserism ever was, and the fundamental cause of the strike evil is the perverted psychology of the working classes which in turn is the inevitable result of conditions brought about by the substitution of the machine for the man, from which no escape seems possible."

There can be no doubt that the " strike evil " has grown to dangerous dimensions. From being the legitimate weapon of the weak against injustice which could not otherwise be redressed, it has become the instrument of caprice or even of blind passion which may be resorted to without waiting to ascertain facts or to seek conciliation. Large numbers of men will suddenly cease work because of some incident at a distance which causes them irritation, thus intervening in disputes which do not concern them. The advice of responsible labour leaders may be disregarded and their authority may be set at nought, reducing the Trade Union organizations to a farce. Or powerful groups may threaten the life of the nation if some measure, which they have been induced to demand, is not immediately granted. We have seen questions of national policy made the occasion for such threats by which the authority of Parliament is defied, and it is because of this apparent readiness to throw over constitutional methods that foreign propagandists have thought it worth while in recent years to spend largely in the hope of utilizing British organized Labour for their own purposes.

While the strike, in the new form of direct action, is a flagrant violation of the principles of democracy, it is economically disastrous

* Offices, 6, John Square, Adelphi, W.C.2. Secretary, Miss A. D. L. Lacey. The objects of the League are explained in Lord Sydenham's address.

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in proportion to the loss of production entailed. Strikes during the war, by hampering the supply of the armies in the field, threatened the lives of our soldiers and prejudiced the cause of the nation. It is impossible to estimate the total national loss they have inflicted since the armistice, and some of them have been unjustified and futile. The moulders' strike affected many industries, created extensive unemployment, left arrears not yet made good, and gave nothing to the strikers which they could not have gained by remaining at work. The indirect results of the strike fever are far-reaching, because they cause the uncertainty which checks enterprise, and they may involve the loss of valuable contracts on which employment depends. As soon as foreign competition again begins to be felt, industrial conflicts will be gravely injurious to the export trade by which we exist. It is certain that the present critical economic conditions can be faced and conquered, but only by honest hard work of hand and brain, by the self-sacrifice which would ensure thrift among all classes and by rigid economy in public expenditure. There are no signs that these supreme national needs are realized, and we appear to be drifting into a grave economic position. While the newly enriched classes have been spending lavishly on superfluities, we see the bricklayer who deliberately restricts his efforts although housing accommodation is the prime necessity of his class, and the coal miner, who with increased numbers, shortened hours, and good wages, does not approach the pre-war output. All this directly and indirectly helps to create the high prices of necessaries of life. The total loss of coal raised is nearly 50 million tons a year, compared with the figures of 1913, and our coal export trade has dwindled with consequences which must be serious.

If we fail to rebuild the national prosperity on a broadened basis, and if the revolutionary movement supported by foreign agency assumes an active form, the cause will be mainly psychological. My American friend attributes the troubles in his country to the "substitution of the machine for the man," which he considers has "perverted the psychology of the working classes." I believe that the menace to civilization, which we can plainly see, arises from a perverted mentality which has affected all classes. The war with all the losses, the restrictions and the privations which it entailed, aggravated psychological tendencies which were visible before. If it is true that science applied to industry is a cause of the present unrest, we who desire the full enfranchisement of science may well consider where the fault lies.

In less than 100 years our country underwent political and economic revolution so continuous and so apparently successful that psychological perversion was perhaps inevitable. The reign of the machine changed the whole life of the country, and became more and more imperious. The existence and the maintenance of the present population depends absolutely upon it. Where, as in

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Russia, it has been broken down by an infamous government, we see starvation, misery, and reversion to primitive barbarism in a rich country easily able to feed the people and to supply raw materials for industries. If it were to break down here even for a time, the suffering would be greater and the disaster would be irreparable.

Politically the advent of the machine transferred power to the towns, left us with a relatively small rural population, and caused the vital industry of the land to be disregarded or relegated to a subordinate position. While the national wealth grew rapidly and riches fell to a new social class, including many manual workers, great towns sprang up, and from want of forethought the accommodation of their constantly swelling populations failed to fulfil the requirements of sanitation or even of decency. From this neglect, which we realize too late, a whole host of evils has sprung. The greatest economic change, was, however, that a small population living mainly on internal resources was quadrupled and came to depend for existence on imported food and raw materials, which could be paid for only by the export trade and rendered secure only by naval supremacy. In no other great country is this condition so inexorable as with us, and, unfortunately, the consequent demands on our production are not sufficiently understood.

I think it may be fairly said that the psychology of the mercantile and industrial classes was warped by concentration upon the organization and extension of great businesses and by the comparative certainty with which, so long as Great Britain had little competition to face, wealth could be accumulated. Success always has its snares, and it was perhaps mainly preoccupation that in too many cases induced forgetfulness of some of the responsibilities involved. Labour presented itself at each centre of new industry, and the conditions of life of the workers were too generally regarded as lying outside the sphere of the employer, while the large numbers dealt with excluded the personal relations between employers and employed, thus entailing want of knowledge of the needs and the habits of thought of the latter. The reign of the machine thus led to the mechanical handling of human beings, which must fail in the long run. There have always been employers who studied the welfare of their manual workers ; there are mining villages which are models ; but it must be admitted that the perversion to which I refer led to excessive working hours and inadequate wages in many cases, and to other conditions which promoted discontent. The war has changed the outlook of many employers of labour. There is now a general desire to meet all reasonable demands. Conciliation by frank negotiations is earnestly sought, but it is not possible quickly to remove evils that have accumulated, and labour having tasted power, does not recognize the new opportunities and the new sympathies offered.

Upon the psychology of the manual workers, the reign of the

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machine exercised a profound influence. The dwellers on the land unconsciously assimilated some great lessons which education so far has failed to impart. They were brought face to face with the inexorable laws of nature. They saw the results of their labours and could trace failure to its causes. They became aware that something could not be obtained out of nothing, and that there was a relation between production and employment. They realized what capital could do for the land and the effect of its absence or unwise employment. Above all, they learned patience. I think that we under-rate the psychological value of the special training which the life of the country provides. The land will come more and more under the reign of science, but the land worker cannot fail to understand the increase of production which will follow from the scientific application of capital to his industry. The land workers now form a small proportion of the whole population, and the psychology of labour as a whole is mainly determined by life in the town and the factory. In the small business, employer and employed were closely associated, and the latter knew the conditions which brought success or failure, while the simple finance involved was within their comprehension. The reign of the machine created huge undertakings. The employer, often working with his men, was replaced by the Board of Directors sitting in secret. The financial complications became unintelligible to the workers who did not understand the brain activities, the thought and the anxieties involved, or the foreign markets on which their employment may depend. There is a sense of satisfaction in the exercise of skill, but the automatic machine performed highly skilled operations while demanding only a certain amount of care and attention. Physical exertion was immensely reduced; but the healthy fatigue which it brings was replaced by the nerve stress of the factory, of which investigations during the war have taught us much. The change must have tended to produce mental irritability, and when these and other conditions, including the dread of unemployment, are taken into account, labour unrest seems a natural result. Many manual workers came to believe that they were unconsidered though essential factors in a ruthless system devised for the benefit of capitalists, and they were therefore ready to accept the doctrine forced upon them that only by the destruction of capital could they attain higher standards of life. It is true that capital in private hands may be tyrannically used, and that this has happened in America especially. Capital in the hands of Trade Unions may also be used for tyrannical purposes. This is a danger to society which must and can be prevented. But it is equally true that wages are highest where capital is most abundant, that the destruction of capital in the war is one of the causes of our own difficulties and of the misery in Europe, that most of the capitalists in this country are persons of small means and that any attempt to deny the right of private saving and to substitute

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nationalization under a Socialist or Communist State will entail the employment of labour under rigid discipline. It would be easy to show that this is inevitable; but we have the appalling object lesson of Russia where civilization has been destroyed by a small minority of self-constituted dictators who are using forced labour in the vain hope of restoring the ruin they have brought about. What this country needs is many more capitalists or, in other words, a much wider distribution of capital.

The problem before us is to reconcile capital and labour, each necessary to the other, and to recognize that a perverted psychology has affected both. Only by goodwill, involving mutual concessions, can the spirit of unreasoning hostility be exorcised, the manual worker be given a new interest in his labour with new opportunities of economic advancement, and this old country of splendid traditions be saved from disaster.

Can the reign of the machine be rendered beneficient to all alike? Can science, which has been the creator of conditions which have favoured the spread of revolutionary ideas, help to provide the antidote? It is a remarkable fact that, while scientific discovery was transforming the national life, there was no corresponding development of science training in circles entrusted with government and administration. When foreign competition began to be felt, it was quickly realized that some of our industries had fallen behind in utilizing the gifts which our leaders of science offered them, and that the Germans had passed us in the great domain of chemistry especially. If this neglect showed itself in quarters where there were strong inducements to turn science to the fullest account, it was certain to prevail in government departments with far more serious consequences to the nation. In a lecture delivered nearly 70 years ago, Professor Tyndall said:—

> "I state nothing visionary when I say that in a country like ours, whose greatness depends so much upon the applications of physical science, it would be a wholesome and natural test to make admission to the House of Commons contingent on a knowledge of the principles of Natural Philosophy."

And he went on to make a powerful plea for the study of physics among the manual workers, "not only as a means of mental culture, but also as a moral influence." Science has immensely extended its dominion since that day, and has become far more closely connected with the welfare of the nation, and, therefore, more urgently needed in every branch of Government. Yet in Cabinets, in Parliament, and among our representatives abroad, Governors, Ambassadors, and Consuls, training in science is conspicuously absent. We have a great and capable Civil Service, which wields large powers in administration; but even a moderate knowledge of the principles of science is not considered a necessary part of its

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equipment. Among the permanent heads of the departments of State, therefore, an essential qualification is wanting. Even the Board of Education is completely swamped by officials who have only had a literary training and may have inherited a traditional disregard of science as an educative force. In the Treasury, now unfortunately a large spending department, in the Foreign Office and the Colonial Office, which must be continuously dealing with matters demanding some scientific knowledge, there are scarcely any high officials able to speak with authority.

The war forced the neglect of science upon public attention; but no estimate of the results of this neglect will ever be possible. It was deliberately decided that cotton was not required for the manufacture of nitro-cellulose, and might safely be admitted to Germany, and that lard also, not being capable of being used to make nitro-glycerine, need not be treated as contraband. Who can tell what this nescience entailed? Examples could be multiplied of grave decisions taken without adequate knowledge of facts and in defiance of the scientific spirit.

In July, 1916, a weighty letter was published in the *Times*, signed by thirty-six leaders of science who pointed out that:—

"Our success, now and in the difficult times of reorganization after the war, depends largely upon the possession of our leaders and administrators of scientific methods and the scientific habit of mind. They must have knowledge and the habit of promptly applying known means to known ends. To trust to luck is a mark of the dangerous complacency bred of ignorance."

This opinion, which few will dispute, was powerfully emphasized at a conference presided over by the late Lord Rayleigh in May, 1916. A strong Committee was afterwards formed, with Sir Ray Lancaster as Chairman, and Sir Richard Gregory as Hon. Secretary, which after a conference with the Council of Humanistic Studies, issued a valuable report. Sir Joseph Thomson's Committee followed with wide terms of reference. This Committee collected evidence of great importance, and its recommendations, if adopted, would go far to give to science a firm footing in the education of the future.

Meanwhile, Government was driven by the dire stress of the war to call science to its aid. Many committees, not always well selected, were set up to deal with the more pressing needs, and trained men of science were drawn from civil life as advisers and directors of research and manufacture. It is not too much to say that the admirable work thus accomplished saved a dangerous situation by supplying our gallant troops with essential requirements, but the pre-war neglect of science could not be wholly redeemed by improvization. In this hall last year, Sir Joseph Thomson quoted from one who was prominent in helping to apply science to military necessities. He wrote that it was a serious defect that in the General Staff at the War Office there was no officer "with any real knowledge of

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science or appreciation of scientific questions." And he added these significant words :—" I hesitate to put down on paper what I believe to have been the cost of this complete ignorance among the General Staff ; but it was at times appalling to me to contemplate."

As the result of the stern lessons of the war, we have set up much useful machinery for co-ordinating scientific progress, and for providing expert advice. Research has received a new impetus, both from Government and from industrial leaders. These are undoubted gains ; but they will not suffice unless the application of what can best be described as the scientific spirit to the solution of national problems is secured, which is the main object of the British Science Guild. We believe that out objects can be attained only by radical changes in our system of education. In a striking address on " The Influence of Science on Education," delivered in 1854, Dr. Whewell summarized the conclusions of Plato, drawn from the study of geometry in his day, in the following words :—

" That there was a certain and solid truth ; a knowledge which was not opinion ; a science which was more than seeming ; that man has powers by which such truth, such knowledge, such science may be acquired ; that therefore it ought to be sought not in geometry alone, but in other subjects also."

The powers of man to acquire the knowledge which is " not opinion " have been demonstrated in realms of which Plato had only a dim idea. The applications of such knowledge have played an immense part in moulding the destinies of mankind ; but science as a great national educative force has not yet won its rightful place, and Plato's quarrel with the Sophists continues to this day.

The British Science Guild holds that it is vital to ordered progress that trained specialists should wield adequate authority in the national councils, and that it is essential and possible to impart such a scientific trend to national education, from the bottom to the top, as will affect the psychology of all classes and help to remedy many patent evils. As Dean Inge has lately pointed out, real progress must be moral in its essence, and Professor Tyndall was right in believing that the study of physics might be " a moral influence." Everyone who has attained an insight into the methods of science must be conscious that his attitude towards questions of all kinds is thereby affected. What we call the scientific habit of thought is acquired by the recognition of eternal and inexorable laws, by the pursuit of truth for truth's sake, by insistence upon proved facts, by the use of accurate language, and by distrust of mere words and catch phrases. Science is the deadly enemy of credulity, which our national education has failed to control, and the political and social effects of which we see every day in exasperating forms.

There never was a time when it was so necessary to prove all things and to hold fast to that which is good. There never was a time when such determined efforts were made to create a perverted

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psychology among the masses now entrusted with political power. Science has facilitated the operations of the propagandist, but has not yet succeeded in creating the mentality which would cause his effusions to be weighed in the balance. There are, I believe, many of our manual workers who are inclined to be distrustful of the mad theories impressed upon them and who are blindly seeking after truth. Might they not have been equipped by education so as to be enabled to form independent judgments and to examine the credentials of their self-constituted instructors ?

Upon Parliament and the Departments of State will devolve increasingly heavy responsibilities. Here also a new mental attitude is sorely needed in order that the gifts of science may be brought to bear without stint upon the national welfare. We want in Parliament a group of members with sufficient knowledge to submit legislation and all public questions to the test of scientific examination as a corrective to the political and opportunist considerations which have led to grievous mistakes in the past.

In so far as there has been psychological perversion due to the causes which I have attempted to describe, the British Science Guild believes that remedies lie ready to our hands—remedies which it has earnestly striven to advocate in its fifteen years of existence, and which, as you will gather from the present Annual Report, it will continue to advocate in the future.

The horizon of the Empire is dark with heavy clouds. We are threatened with greater dangers than that of German militarism, which has been broken mainly by the spirit of the British race. The survival of civilization, already submerged in some parts of the world, turns upon the application of scientific knowledge to the national life. We can fulfil the vital requirements of our people only by complex organizations, the disintegration of which would mean suffering, starvation, and disease, because nature cruelly punishes the violation of her laws. If knowledge is power, as Bacon held, it follows, as Goethe said, that " There is no more dreadful sight than ignorance in action," and Plato, who anticipated Goethe by more than 2,000 years, pointed out that the spectacle is more dreadful in proportion to the capability and the energy of the ignorant agent. I firmly believe that upon the psychology of the British people the future of civilization must largely depend. We can, if we will, not only reconstruct our prosperity on broader and more stable foundations, but help to save the stricken and distracted peoples of Europe. Whether we rise, as an Empire, to the accomplishment of the mission which Providence holds out to us, or whether we go under like the great Empires of the past, will be determined by the moral qualities, which our race retains from the training of its long history, from the teaching of its greatest men, and from the shining example of its heroes on sea and land and in the air.

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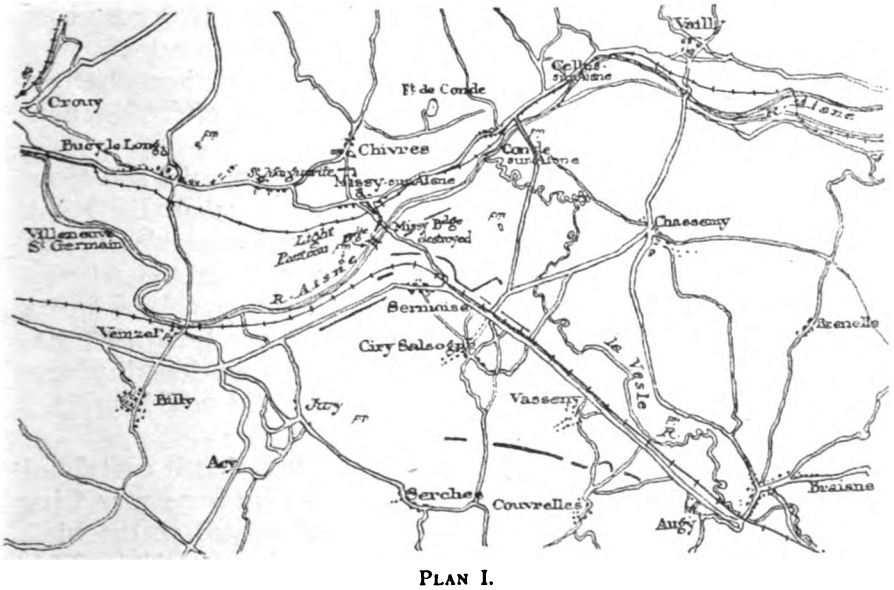
FROM THE AISNE TO YPRES, 1914.

FURTHER INCIDENTS IN THE STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG. GENERAL G. WALKER, D.S.O.

IN my last article, published in the *R.E. Journal* of April 1919, I carried my narrative down to the end of September 1914, but there is one more incident which occurred during the construction of the light infantry bridge at Missy which is worth recording. It happened to Johnston. Very strict orders had been given that there were to be no lights and no smoking. We officers had electric torches and Johnston lent his to a N.C.O. to examine some detail of the work. They got separated in the crush and not long after, Johnston, to his horror, saw a torch beam being flashed all over the place. He rushed up and incontinently knocked the offender, whom he did not recognise, into the river. After he had done so he enquired; "Who is it?" He was told it was the man to whom he had lent his torch. The unhappy victim as soon as he was fished out made most humble apologies to Johnston for dropping the torch in the stream, little knowing whom he had to thank for his ducking!

The military situation was now more or less as follows: (*Plan* I)—



PLAN I.

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The 5th Division held the village of Missy on the North side of the river with one Brigade, their position being connected with the South side by the pontoon (" medium ") bridge at Venizel and the " light " pontoon bridge not far from the site of the broken-down road bridge at Missy itself. Our brigade (13th) prolonged the line eastwards along the south bank of the river to meet the 3rd Division which were in and about Vailly. The third brigade of the Division was I think in reserve somewhere between Sermoise and Serches. The 14th and 15th Brigades relieved each other in Missy.

Condé bridge was in front of the 13th Brigade and was in the hands of the Germans and no one I believe could get to it. We tried one night but with tragic results. This bridge was a source of constant anxiety and was watched by some of the North Irish Horse. It was this right section of the line that the 59th Company was concerned with. Our work consisted in assisting the infantry on the front line near the river (but not much help was asked for) and building a second line in front of Sermoise and Ciry Station with the aid of infantry working parties for whom we had great difficulty in getting tools. The line ran roughly parallel to the railway and sometimes actually along it where it lay in a cutting. Here we could work by day but most of the work had to be done at night. I remember that there was a good deal of doubt at one time in the minds of some people as to where this line ran. One night when I arrived with my men I found a stray Infantry working party extended for work at right angles to our trenches. I thought they had been sent without warning to help me and I suggested this to the Commander and also that he should extend along my line. However he said he knew nothing about me, that his Colonel had given him his job and that he must carry it out. The result was that we both dug that night at right angles to one another. Rather a waste of energy and indicative of a certain want of combination somewhere.

The details of the work were of the simplest, as parties and tools were very short, and the result was little more than the most rudimentary line of trench, to form the nucleus of something better later. We did I remember start some dug-outs in the railway cutting. Curiously enough, although the German aeroplanes must have known all about it, I do not remember our being shot at, though they did shoot at Ciry station and the farm behind it where we lived, the batteries south of the road and in the neighbourhood of Ciry village.

One peculiarity of this part of the country was that it contained a series of prehistoric cave dwellings. There were some near Ciry village but the most intricate and the largest existed on the high plateau above the village and about 1½ miles to the east of it. This

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was a most extraordinary place, which had to be explored with lights. Chamber after chamber existed, some large and some small. It was supposed to be a harbour for spies and at one time was guarded, though I never heard of anyone being discovered there.

Besides the front lines along the river we were also engaged on a third retired line on top of the plateau. It came from near Serches towards Couvrelles on the flat ground on top and then dropped down into the low country to cover Couvrelles and ran between that place and Vassemy and then on east towards Braine.

We did a lot of work on the portion actually covering Couvrelles. It was a troublesome job, as the location of the line ran through a very thick wood and along very steep ground. There was a great deal of clearing to be done and the clearance of the timber was a great problem. The C.E. of the Corps I remember was much concerned about this part and often came to see us at work.

We were well hidden and worked all the time by day. The routine was roughly half a company here and half a company near the river on alternate days. Tools and materials were the difficulties as usual at this early stage of the war. We were much concerned about spies also at this period. We were warned of a motor car with head lights, that was said to run along the Braine-Sermoise road at night, the departure of which was supposed to be followed immediately by German shells. I was on the road at Ciry station one night and saw such a car approaching. I signalled it to stop but without effect, so as it came up to me at a good round pace; I drew my revolver and presented it at the driver. Such a scrunching of wheels and screeching of breaks as the car tried to stop in its track and then out of the back a figure scrambled and came up to me. I recognised him as the son of a very old friend of mine at home in Kildare, a young R.A.S.C. officer, who had been a cadet in the Sandhurst Company at Woolwich, when I was a teacher there in 1905. He was full of apologies needless to say—I told his mother about it long afterwards to her somewhat doubtful amusement.

Towards the end of September rumours of a move had been in the air, and a Field Ambulance, that had been quartered with us at Couvrelles and which had tried hard but ineffectually to evict us from the Chateau, had disappeared secretly one night when we were out at work. They never told us they were moving, (where they were going would not have interested us in the least) and when we got back from work in the morning we found that a lot of sponges, razors, &c. had disappeared. My kit had not been touched but all the

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others had lost things. I wrote a polite note to the O.C. suggesting that perhaps the batmen in the dark and in the hurry of departure, had mistaken some of the rooms. I got a rather indignant reply, but no sponges or razors. I hope Heaven will forgive me if I did those batmen an injustice.

On the night of the 2nd October we left our comfortable billets in Couvrelles Chateau where we had passed a pleasant fortnight with the 12th Lancers and the Scots Greys of Sir Phillip Chetwode's brigade. Comfortable beds, good food, baths, and electric light (run by my servant) had been the order of the day and we were sorry to leave them. We had short notice of this move. The C.E. came to see us in the morning and asked if I had any orders and, when I said 'No,' he replied that I ought to know, as they were coming. Of course we started packing at once and I think, if we had not had this timely warning and had waited for the orders to come through the ordinary channel, we should never have got off to time. As it was we were all ready and moved to join 13th Brigade at 7 p.m. It is worthy of note that the bridging equipment which we lost at Mons, 5 weeks previously, was replaced at noon this day. This shows the difficulties we were labouring under owing to lack of stores.

I was much amused at two incidents that happened here. The first might have been a tragedy but the tragedy missed fire. We had returned to our billets from our work on the river, when, at about 3.30 a.m., our Adjutant, J. R. White, came in and woke me up telling me that the Germans had crossed the river in large numbers at Condé bridge and that we were to go up and man the second line trenches and hang on until the reserve Infantry Brigade relieved us. We had dug these trenches and knew the ground well. We all turned out with rather mixed feelings and started. It was a lovely autumn morning, not a cloud in the sky, not a sound in the air and I could hardly believe that we were in for what would have been the scrap of our lives. However, we manned the line, served out ammunition and took such precautions as were possible, to enable us to get good warning of the hostile advance. We sat on the hills until near 8 a.m., and nothing happened and eventually got a message to withdraw, as the show was off. On our way back to bed we met the relieving troops of the 13th Infantry Brigade, who had marched miles to our rescue. Their feelings beggar description and we left them to ruminate on the result of the dreams of ghost-seeing subalterns. I believe the scare started on the report of a subaltern commanding a picquet on the river near Condé, but I have never been able to get at the rights of the case.

The other incident was less disconcerting. The Commander of the 13th Brigade came into the Chateau park one morning just after

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the arrival of our first reinforcing draft, since we had left home. A good strong draft it was, made up of good, lusty, clean and well-fed men. We gave the Brigadier a general salute and he proceeded to inspect. When all was over he said to me that we were a wonderful Corps—" Just to think that those fellows have been all through the great retreat." I confess with shame that I did not reveal the real state of affairs. The men who had been through the mill deserved the eulogy too well. Enough of digression, however.

We left Couvrelles at nightfall on 2nd October, as stated before, and started to join the 13th Brigade en route for an unknown destination. We marched all that night to Violane where we spent the day. On the road again next night and so marched by night and slept by day until we arrived at Pont St. Maxence on 7th October. Our actual halting places were Longpont 4th, Buy 5th, Bethisey 6th. We entrained rather disjointedly on 7th—Headquarters & Nos. 2 & 4 Sections at Pont St. Maxence--No. 1 Section, Compiegne—No. 3 Section, Le Meux. It was not an unpleasant walk as the peasantry were most kind. At Buy, the old gentleman farmer on whom we were billeted, told me the Boche had taken all his horses, the French Army had his sons and he and his wife and daughters had to run the farm. At dinner that night he came in with a magnum of sweet champagne and asked if we would honour him by drinking it. I replied that we most certainly would, if he would join us, and down he sat. We had a very pleasant evening and no sore heads after. He was a charming old gentleman, in spite of his dirty threadbare clothes, and discoursed volubly upon the war in general and the iniquities of the Germans in particular. The march was without incident except for an occasional jamming of the troops on the road in the dark. I think it was during this trek that we had our first church parade at Longpont. There was no chaplain but, as it was the first Sunday since we started that we had not been actually in action, Johnston and I thought we would have a voluntary church. We were billeted in a chateau stable and we had our service under some cedar trees. A good few of the men turned up and I just read the morning prayers for them. We made this a regular practice from this on, whenever we had a quiet Sunday. I think the men were shy of it at first, but I believe they got to like it after a bit.

Pont St. Maxence presented but little of interest except the improvised floating barge bridge put up by the French alongside the stone bridge, which had been blown up by somebody during the retreat. It was here that we first began to realise that we were going north again. We had got in early in the morning and had a whole day to look about and pick up the news. We entrained at 7 p.m. and started off via Creil for Abbeville. We got to Creil about

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8 p.m. As we sailed into the station I heard a dreadful hubbub on the platform and on getting out found that one of our horses had fallen down in the cattle truck and was lying on the floor with his fore legs hanging out. How the door got open is still a mystery. We had a troublesome job to get him on his legs again and back into the truck. General Sandbach, C.E. 2nd Corps, Flint and myself were the chief actors and when all was done the French station-master started the train, without giving Flint or myself a chance of getting back to our carriage. There we were, left behind, with the Company gaily going off to Heaven alone knew where. However, the General got the train stopped somehow, just outside the station, and we were able to rejoin it, so all was well. We reached Abbeville at 4 next morning, detrained and from thence began our march to Bethune (October 8th).

After breakfast and a wash we started on our march to the N.E. A good billet at Millencourt that night, rest next day and then on *via* Genne—Ivergney to Haravesnes where we got into busses and arrived at Rosemont near St. Pol (11th October). We got in about midnight and were off again at dawn with the advanced guard of the left, or northern, column of the 15th Brigade (it marched by 2 roads). It was an uneventful day, but a long march, and we could hear the French guns in action on our right. We did not actually go to Bethune, but to Hinges via Chocques, we arrived late in the afternoon—too late to do much.

We found the Germans on the canal at Avelette and our infantry in touch with them. However there was no action that night. The company billeted at Oblingham, No. 1 Section remaining with the advanced guard group. I think the Germans must have drawn off during the darkness as we crossed the canal quite peacefully next morning at Avelette (October 12th) and marched on through Locon and Merplaux to Le Touret on the road to Richebourg L'Avoué; a place that we were not to reach however for some time nor without a lot of fighting (*Plan* II). We got to Le Touret quite early this morning (October 12th) and there met the French Cavalry (Cuirassiers) whom we were to replace. There was a good deal of promiscuous scrapping going on and our infantry were feeling their way up towards Richebourg L'Avoué. We were with the 14th Brigade (Brig.-General Rolt) who met the French Officer Commanding the Cavalry at the Le Touret estaminet. There seemed to be a good deal of doubt as to where the French advanced posts really were. Their G.O.C., a fiery old Cavalry man, stated that they were in an almost impossible situation and this our Brigadier took leave to doubt. The old man was furious and said "If you don't believe me I will get a Regimental Commander to verify what I say." On the arrival of the Regimental Commander the latter gave the

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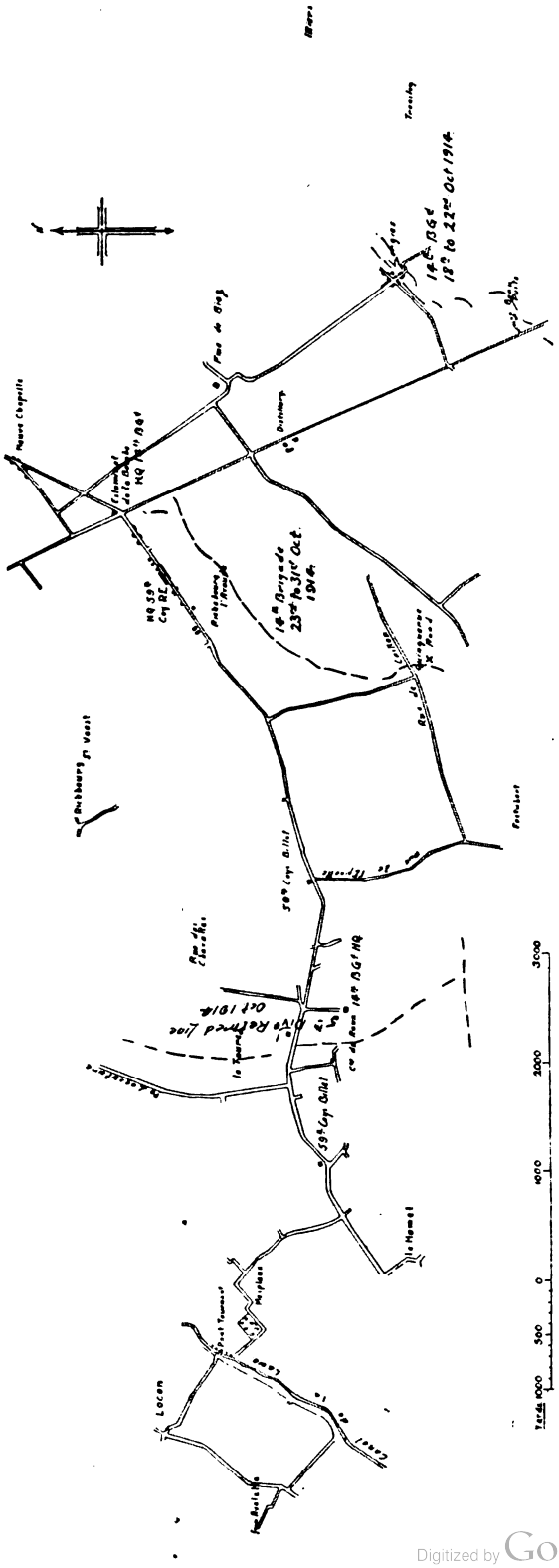
Wavre
Tervuren
Forest Chapelle
Forest de Soignes
Duisburg
14th Brigade
23rd to 31st Oct.
1914.
Roulers
Zonnebeke
Langemarck
Poelcapelle
Passchendaele
Becelaere
Gheluvelt
Zandvoorde
Zillebeke
Hollebeke
Wytschaete
Messines
Ploegsteert
Warneton
Armentieres
Le Gheir
Le Touquet
Le Maisnil
Lacon
Steenwerck
Merville
Estaires
Bac St. Maur
Aire
Thiennes
Hazebrouck
Cassel
Bailleul
Neuve Eglise
Wulverghem
Wytschaete
Messines
Ploegsteert
Warneton
Armentieres

whole show away by saying that the posts were nowhere near as far ahead as was supposed. Tableau! Much vociferous talking among the French and we got on with the business in hand. I was much surprised to see these French "Tins" wearing their breast plates. The men's were dirty and rusty, but those of the officers were shining nickel or silver plate, and this was modern war.

We now commenced a furious struggle to surround and take La Bassée. The 13th and 15th Brigades went for it direct through Givenchy and Festubert while we, with the 14th, "fetched a compass" via Richebourg and Lorgie. The 5th Divisional Headquarters was at Gorre Chateau. It was slow work in the flat blind country. The weather was fine but the land was so flat that we could seldom get a view. There was little engineering work. The sections of the company were detailed to work with the four battalions of the Brigade while the Headquarters remained with Brigade Headquarters. The work of the sections amounted to little more than improving and strengthening positions taken and improving communications.

On the 13th the Company Headquarters were moved back to Locon to reconnoitre a site for a pontoon bridge and we billeted there that night but we were all reunited again next day at Le Touret (14th).

The Germans delivered a very heavy attack about 6 p m. on the evening of the 14th and no work could be done. We lost Pennycuick wounded this evening—our first officer casualty. He was a great loss to us and had already won a D.S.O. So we moved on north-eastwards, pretty slowly and the Brigade made good Richebourg L'Avoué on the 17th October and we took up our quarters there that night in a comfortable house in the main street. The advance had been pretty slow—5 days doing 8 miles. However, we were going ahead which was the great thing. About this time I had an amusing experience. I was standing on the road near Le Touret talking to the O.C. of the Field Ambulance billeted next door to us when a car containing a smartly dressed individual drove up and stopped. I recognised the occupant as a civilian of my acquaintance. On being asked what he was doing he replied that he was making enquiries as to the treatment of the wounded by our doctors, as there had been some complaints about it. He was not a doctor himself, and I thought it rather tactless of him to broach the subject so boldly in the actual presence of a senior officer of the R.A.M.C. I told him that I had no complaints from my own men but that, if he wanted first hand information, I would take him up to where people were getting wounded and he could look into things for himself. He thanked me profusely and said he had an appointment in quite the opposite direction and left us, much to the

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amusement of my doctor friend. I never heard any more of him or his mission.

The R.E. got into Lorgie on the night of the 18th and we started strengthening the place and positions in the neighbourhood. The General idea of the defences is shown in *Plan* No. II.

Our direction had now changed nearly south and we were within 2 miles of La Bassée. Antwerp had fallen but we still lived in hope. The general situation was—5th Division on a line from the La Bassée canal through Givenchy—Festubert—Violanes—Beau Puits—Lorgie —3rd Division from thence through Illies and Herlies. The greatest pressure from the Germans seemed to be on the left, though we all had plenty of excitement. Poor Carr got a shrapnel burst all over him in the village street of Lorgie on the 20th. He had asked me for leave to go up, in daylight, and see something that his section was to do that night, and I let him go with much misgiving—— as he did not return I took the section up myself and found him in the dressing station. He was knocked about a lot but not badly wounded. He left that night for the base. We never saw him again as, when he recovered, he returned to France with the 27th Division R.E. and was killed near St. Eloi in February 1915. Poor fellow, he had joined us straight from Chatham in August, knowing nothing but what he had learnt from books. He made good wonderfully quickly and, like every good officer, soon gained the confidence of his men.

Our work at Lorgie consisted in entrenching the line from Beau Puits, which was in the 13th Brigade area through Lorgie towards Dalluiq. We had some advanced trenches down in the valley below Lorgie towards Le Transloy. The Germans were very active in and about Le Transloy. We called them trenches in those days but little more than a 3′ × 3′ trench suitably traversed could be made. There were no materials for revetments, no wire, no R.E. stores, and no parks to draw them from. Tools also were very scarce— we could get nothing except what we requisitioned on the ground. It was a great handicap to our work and one can only trust that things will be better next time. The R.E., although in the front line every night, did not suffer heavily; they were dog-tired but were well fed and housed near Brigade Headquarters which was at the "Estaminet de la Bombe"; afterwards I think called Port Arthur. Luckily the weather was pretty fair.

At Lorgie I saw one of the hottest fire fights that I have ever been in. I was passing through the village one night on my way from the right to the left of the line and was talking to a Battalion Commander at his H.Q. when the storm broke. Every gun and rifle in the country seemed to be going, both British and German. We took shelter behind a house to see what would happen and in

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about 20 minutes the whole thing was over. Flint told me it stopped he thought by the men going to sleep over their rifles. There was no attack and no movement of any sort. When I got to Flint's section I found they had been shooting also and had lost 2 men killed. On my way to them not a shot came up and I walked along the ground at the back of the fire trench in the full glare of a burning rick without anything being thrown at me. The men in the trench seemed dead asleep and quite uninterested.

We had no shelters and no communication trenches and the men just lay huddled in the fire trench. The army was very tired, worn out almost, but their tails were well up. The R.E. were better off than most, as the orders were that they were to withdraw at dawn, so they got a quiet day with good food and sleep. They marched about 3 miles to and from their work, however, daily and were on their legs from about 4 p.m. until 6 or 7 next morning. However, it seemed to suit them, as they were always fit, there was no sickness, and they were always cheerful.

Our stay on the Lorgie line was not a long one. The pressure on the left of the 3rd Division, on our left, soon told, and on the 22nd October the blow fell. It was a terribly mixed-up affair. We had been with the D.C.L.I. below Lorgie until daylight and had moved back just before the attack. The D.C.L.I. were badly mauled and lost a lot and I believe the 3rd Division lost a whole battalion prisoners about the same time. We got back to our billets about 7 a.m. and at 11 I was told to be ready to complete the reserve trenches, which had been already commenced by civil labour, between Estaminet de la Bombe and Quinquerue cross roads on the Rue du Caillou, by dawn next morning. The length of line was about 3,000 yards. I had never seen it and did not know what the civilians had done.

Johnston and I spent the morning with the C.R.E.'s Adjutant going over the place and making up our minds what to do. We had the company at work by 2 p.m. Each section on a bit, to try and make the line for the Infantry to hold that night. I have forgotten how many men we had in the company then but there was no one else and I imagine it worked out to about a man to every 30 yards, including trenching and wiring. However, we got at the worst places and went ahead.

Later on I was told that I must guide the troops to their positions as they came in, anytime after midnight. I said that I would show them into the pews that I had dug, but that the C.R.E. must see them into those that he had provided. We worked on without pause until the troops arrived about 5 a.m. (23rd October). I shall never forget the pew opening ceremony. Every Colonel told me I was a lunatic to think that his battalion could hold so long a bit and there

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were many other remarks. However, I said "G.O.C.'s orders," which was a lie, as the orders were my own. However, we got them all settled in eventually. Meanwhile the work went on until daylight and then we broke off. Our men had worked about 14 hours on end and some of them were staggering with fatigue. However, they were all cheerful and marched off to their old billets at Le Touret. The Germans did not appear until 10 a.m. and then did nothing much. Our infantry held and improved those trenches until withdrawn on the 30th Oct. God knows how they did it. They were weak in body and in numbers but they must have fought by some special inspiration. There were practically no reserves. One night I know we had only 2 companies on our side. The Brigadier's Headquarters was now at Du Raux farm. He and his staff must have had a most anxious time. We were not so badly off, as we had no time to think and saw what was going on in front every night.

While the 14th Brigade was holding Lorgie we were billeted in Richebourg L'Avoué but when the Brigade withdrew to the line Quinquerue cross roads—Estaminet de la Bombe—we went back to our old billet in a farm near Le Touret. Our work consisted entirely in helping the infantry to improve their new trenches and assisting in the execution of the Divisional second line from Lacouture on the left and passing just in front of Le Touret towards where Rue de l'Epinette joined Rue de Caillou.

The work on the front line was of the most elementary description owing to lack of men and materials. We used barbed wire from fences and timber from local wheelers' shops and so on. One day long afterwards in Salonika I received an enquiry, from the Compensations Commission in France, asking for particulars. The questions were as follows :—Had I really had the material I signed for, had I really used it and what for, had I ever recovered any of it and returned it to the owners, and finally, could I remember what was the distance apart "*in inches*" of the barbs on the wire? I always knew that financial mills ground very closely but I never realised how closely until then. I forget what my answer was but I doubt if it was polite. Yes—we learned then, by bitter experience, how bad our store organisation was.

The infantry did a lot of work now and the trenches improved fairly rapidly but there were no communications and one could not get into the trenches except in the dark. Johnston and I had a nerve racking experience about this time (28th Oct.) we were told to site a switch from Richebourg L'Avoué behind Neuve Chapelle to join up with the 3rd Division on the La Bassée Chaussée, North-west of Neuve Chapelle. We got out at daylight and found everything quite peaceful. We wandered about with our map, when

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suddenly 3 field gun shells burst, one in front of me, one behind Johnston and one between us but slightly to our right, (we were walking about 20 yards apart). Needless to say we were in the bottom of a deep ditch in less time than this takes to write and then 6 more rounds came up to look for us. Where the fire came from Heaven knows, but it was a sporting, and very nearly a successful, effort on the part of the German gunners.

(To be continued).

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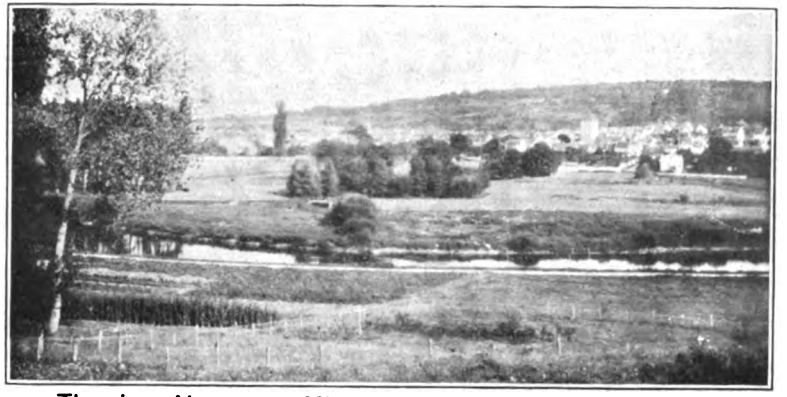
Entraining, Havre, 20th Aug., 1914.

On the march during the retreat.

A halt on the march to the Marne.



The river Aisne, near Missy, looking south towards Sermoise.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

In September, 1919, *The Royal Engineers Journal* published an introductory notice and proposed synopsis of the official records of "The Work of the Royal Engineers in the European War, 1914–1919," which were in course of preparation for publication, and since that date portions of these records have appeared in every number of the *Journal*.

It has now been decided that the more important of these records shall be published by the R.E. Institute in book form. Only a very limited number of copies will be printed, and these volumes will be sold to members of the R.E. Institute at prices, ranging probably between five and ten shillings, which will be about half the prices which will be charged to the general public.

The publication of the following volumes is being taken in hand at once :—

Work under the Engineer-in-Chief, B.E.F.		—Water supply.
do.	do.	Mining : Historical and Mine Rescue Work.
do.	do.	Mining : Technical.
do.	do.	Bridging.
do.	do.	Camouflage, Workshops, Machinery, and Electricity.
do.	do.	Geology.
do.	do.	Experimental Section.
Work under the Director of Works (France).		
do.	do.	Plates only.
Egypt and Palestine Water Supply.		

The Secretary, R.E. Institute, Chatham, would be glad to receive the names of members who wish to reserve the right to purchase the various volumes as they appear. (A form of notification is enclosed).

It is not at present contemplated to publish the whole of the records in book form, and some of the shorter reports will continue to appear from time to time in *The R.E. Journal*.

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CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

SIR,—With reference to the article "Organization and Employment of Engineers in War," which appeared in the May number of the *R.E. Journal*, I am not in favour of the organization of the Divisional R.E. into three double companies for the following reasons :—

(*a*) The three double companies would absorb an undue number of officers in their three headquarters.

(*b*) That organization approximates to a three-battalion organization of two companies each, which I do not consider advisable for the reasons adduced in paragraph 15 of the article in question.

2. I would suggest instead, four companies, each of approximate strength of 350 (Sections, 70 strong), and a headquarter company, cheifly skilled tradesmen, approximate strength 120.

C.R.E. to have the same rank as an Infantry Brigadier and to have a Brigade Major (substantive Major), Staff Captain and, if considered necessary, a Stores Officer working under and assisting the latter.

Establishment of officers for each of the four Field Companies to be :—

1 Major Commanding.
1 Senior Captain (G), 2nd in Command and for operations and liaison work with the Infantry Brigade, etc.
1 Captain, duties as at present performed (A and Q), (A and Q work, Stores, etc.).
6 Subalterns : 1 per section, 1 to assist Captain (A and Q) or replace casualties (5th Sub.), 1 spare to replace casualties, leave, etc. (6th Sub.)

3. This organization permits of a force of 2 Sections under a suitable Commanding Officer (the Senior Captain), being detached, if required, to strengthen the working party in another sector or to carry out work for units other than infantry, *e.g.*, R.A. or R.A.M.C. The 5th Subaltern would normally accompany this force.

Establishments of officers for the Headquarter Company to be :—

1 Captain,
3 Subalterns (1 spare for casualties, leave, etc.).

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4. The advantages of the four-company organization appear to me to be as follows :—

(*a*) It preserves the individuality of the company as a unit and is a more satisfactory command from a Company Commander's point of view.

(*b*) It is at least as flexible an organization as the double-company one, as it can if necessary be split up into eight units—each of greater strength than one section, suitably commanded and administered.

(*c*) It requires a smaller establishment of officers for approximately the same total strength.

(*d*) In position warfare when the line is held as a two-brigade point, up to two companies can, if required, be allotted to each sector. When the line is held as a three-brigade front, one company can be allocated to each sector, and one company held as C.R.E.'s reserve, or for communications, etc.

(*e*) In open warfare one company can be allotted to each Brigade, and one company, together with the Headquarter Company, kept as C.R.E.'s Reserve.

5. As late O.C. 5th Field Co., R.E., and C.R.E. of the 23rd Division with experience in both position warfare (in France, Flanders, and Italy), and in open warfare (in Italy), I would personally prefer to have my command organized as outlined above rather than organized on the double-company system.

Yours, etc.,

E. H. ROOKE, *Lieut.-Colonel,*
C.R.E., West Africa.

REVIEWS.

CEMENT.—MONOGRAPHS ON INDUSTRIAL CHEMISTRY.

By BERTRAM BLOUNT.

This book is written more for the benefit of the cement manufacturer than for the concrete engineer. For the former it contains much useful information regarding old and new methods of manufacture, detailed descriptions of the best methods of testing and latest types of machinery, and valuable suggestions for works management and works economics. To the latter the book is chiefly of historical and scientific interest. The chapter on the " Effects of various substances on Cement " is informing and of interest to all users of cement and concrete.

J. C. P. T.

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TELEPHONIC TRANSMISSION.

By J. G. HILL. (Longmans, Green & Co.). Price 5/6.

This book is one of the "Manuals of Telegraph and Telephone Engineering," edited by Sir William Slingo, late Engineer-in-Chief to the G.P.O. The first part deals with the calculation of direct and alternating currents in lines with resistance, leakage, inductance, and capacity, and discusses in detail the questions of phase, power, and reflection. Loading is then dealt with, from the theoretical and practical points of view. Practical applications are considered, including cost problems, phantoms, and repeaters, the general object being to provide data for, and methods of, dealing with problems, suitable for use by engineers and designers of telephone systems who have to construct the cheapest system of communication consistent with efficiency. The standard of mathematics necessary to follow the discussions includes knowledge of elementary calculus, the relations between trigonometrical and exponential functions and a slight acquaintance with hyperbolic functions, which are extensively used. A mathematical introduction contains many useful formulæ and proofs, and an introduction to hyperbolic functions. The general treatment is on the whole clear, but some criticism may be made. There are many unnecessary cross references which could easily be dispensed with. Diagrams, of which there are many that are very useful, have in some cases insufficient explanation on the same page. The number and frequency of examples might be increased with profit, but those given are practical and practically worked out. The symbols used are consistent, but letter suffixes, as used by Dr. Kennelly, seem preferable to figure suffixes, as being more explanatory and less liable to confusion. The book contains data and methods for the solution of most problems that are likely to be met with, but it is not arranged in a manner likely to help a reader to find quickly the data and methods required for the solution of a particular problem. Altogether one gets a very good idea of the problems that have to be faced by a permanent-line engineer and how they are met in practice, including very modern work, such as the development of repeaters, which are very well dealt with in the last chapter. Special features of this work are the numerous curves and tables, frequency of reference to original papers, and the close attention to cost consideration. The book should be very useful to permanent-line engineers, but in the Army it would probably be of use only to specialists with units constructing long permanent and airline routes, when loading or the use of repeaters might be resorted to. In this case it would give the information required to obtain the best results. The only errors and misprints noticed are:—Page 37, "A transmitting current of any length"; page 166, Fig. 2 should read Fig. 87; page 166, "the diameter of the wire may be taken as 171 miles."

R. H. NISBET, *Lieut., R.E.*

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NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 92.—*The Economic Consequences of the Peace*, by J. M. Keynes, receives a prominent notice and evidently raises hopes of a revision of the peace treaty. A writer complains that the state of affairs in Germany is rapidly approaching that in Russia; prices are soaring, the fixed salary classes are starving and trade can only be done by barter, while the printing presses are working overtime turning out valueless bank notes.

Official Notices.—So many fraudulent transactions are taking place in connection with the exchange of Bermondt notes that in future cashiers will only change up to 300 marks for individuals who can prove they formed part of the Baltic troops.

No. 93.—*Courts of Honour.*—Lieut.-General von Altrock advocates the re-establishment of the officers courts-of-honour which existed before the revolution. Provision has been made in the regulations governing the new army for tribunals very similar to the old courts but somewhat limited in scope and power. Von Altrock regrets this and advocates the formation of courts on pre-war lines by every officers' union. This craving for definition by some superior authority of what is proper and what is not is very characteristic of the German. How is he to know how to behave if nobody tells him?

The Riddle of the Marne is another article on one of the many books now appearing dealing with this subject. This one, by General von Hausen, describes the action of the Third Army and blames von Bulow's (2nd) Army for the holding up of the German offensive. Von Bulow, as has already been seen, is quite prepared to take the responsibility for his action.

The *M.W.B.* now publishes in each number an appeal to all who wish to stand for really unprejudiced and impartial writing on the war to increase the circulation of the *M.W.B.* "Our children must not learn from enemy sources."

Roll of Honour.—Jager Battalion No. 8.—51 officers and 1,422 other ranks.

No. 94.—*Memories by Lord Fisher* is reviewed at length and with much satisfaction, as proving once for all that England willed the war from the very first, that Germany carried it on successfully right up to the Armistice and that even then the German Army was only defeated by a stab in the back from its own people.

Roumania and Soviet Russia.—The writer comments on the many contradictory rumours current regarding the probable course of events between Russia and Poland and concludes that, whatever happens, an offensive by Poland against Russia cannot be undertaken. (This appears on the 28th February and recent events have, so far proved the writer a false prophet. It is to be hoped that he is equally wrong in his estimate

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of conditions in Roumania). He declares that Bolshevism has so permeated the Roumanian Army that, far from being in a position to attack Russia, it could hardly defend itself and that it remains to be seen if Soviet Russia will renounce the certain victory that awaits her if she cares to take the offensive in that direction.

Roll of Honour.—Infantry Regiment No. 61.—91 officers and 3,677 other ranks.

No. 95.—*Technique in the War* is an apparently monumental work edited by General von Schwarte. Its reviewer remarks on the lack of recognition which the subject received before the war. He says that general staff officers were rewarded for good work by accelerated promotion but that heavy artillery and pioneer officers got but little recompense. Since the war, however, every prominent writer has felt compelled to recognize them and this book will provide a record of the great work they accomplished.

Swedish Opinion on the Versailles Treaty.—The *M.W.B.* is delighted to find that a Swedish writer holds correct views regarding the treaty, and describes it in the best German manner. He gives still greater satisfaction by declaring that the next generation of Germans will throw off their chains, and then the world will learn what *vae victis* really means.

The Military Political Situation—This article repeats the often-expressed opinions regarding Anglo-Russian and Franco-Polish relations. The hatred of Poland is a very marked feature of present day German feeling. The surrender of war criminals still receives much attention and the writer is glad to find that Germany, in resisting this, retains a particle of that national honour which she so cowardly surrendered in November, 1918. He suggests that the German Government should now forward its list of those who, on the Allies' side, have been guilty of war crimes and demand their trial. Material for such a list is, he says, all ready and based on unprejudiced sworn evidence, but the absurd irresponsible accusations made by the Allies need not be considered.

Sport in the Army.—The new German Army is to go in for sports in a very thorough manner and text books for its guidance are being drafted. Every man is to have his sports kit and every station to be provided with the necessary grounds. Instructors will be appointed and rules drafted for competitions both inter-unit and with civilian clubs.

No. 96.—*Battles and Combats of the Great War*, 1914—1918 is the title of the final publication by the General Staff, prior to its abolition. Judging from the reviewers' account of the book it appears likely to constitute a very useful work of reference for future historians.

German Mission to Austria.—Lieut.-General von Kramo publishes his story of his work as chief of the German Mission to Austria. He exposes the intrigues of the Austro-Hungarian court and describes how on the death of Franz-Joseph, the new Emperor fell under the influence of the pacifists to such an extent that eventually no reliance could be placed on him.

Settlement of ex-Soldiers.—The question of the setttlement of ex-soldiers on the land is again discussed. The writer urges the use of the old

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Army training areas for this purpose; as these were naturally chosen largely because of their worthlessness for other purposes, the unfortunate ex-soldiers will not benefit much from them; such areas as Paderborn and Elsenborn being about as valuable, agriculturally, as the Long Valley at Aldershot.

Cavalry Equipment.—It has been decided that the new Army Cavalry shall carry lance, carbine and short side arm. The sword is, provisionally, abolished.

The Two White Nations, by Capt. von Hase, of the German Navy, begins with pre-war reminiscences of the good feeling between English and German ships. The title is from a toast alleged to have been given by a British Admiral to his German colleague at an international "demonstration" in the Mediterranean. Capt. Hase, who was gunnery lieutenant on the *Derfflinger* at Jutland, declares that, had Lord Jellicoe pressed for a decision on that occasion, the British fleet would subsequently have had to yield its mastery of the seas to America. He also states that the fight, even if it did not bring final victory, had a splendid moral effect on the German Navy and nation.

No. 97.—*The Maintenance of Tradition in the New Army*—The writer emphasizes the importance of this and also the difficulties attending it. According to his estimate an infantry regiment in the new army will not as a rule have more than four pre-war officers and often fewer. In the other arms things will be even worse. The situation as regards non-commissioned officers is much the same. He concludes that the company will therefore be too small a unit to have any corporate spirit, but that the battalion will be the heir to the traditions of the units of the old army which are represented in it, and recommends that the Ministry of Defence lay down the lines on which this is to be effected.

The Legend of the Illegality of the Submarine War.—Captain Gadow, after patting himself on the back over the upshot of the controversy regarding the surrender of war criminals, discusses the legality of unrestricted submarine war by comparing it to the blockade by the British fleet and reaches the usual German conclusion. He remarks that whereas the U boats caused the loss of 14,661 British lives, the hunger blockade raised the death rate in Germany to such an extent that the German loss amounted to no less than 763,000, without reckoning decline in birth rate and after effects.

It is announced that berths in sleeping cars can be used at certain Berlin railway stations at 15 marks a night.

This number of the *M.W.B.*, which is dated 10th March, is the last which has come to hand. On the 12th Dr. Kapp and General Luttwitz started their singularly unsuccessful *Putsch* and it may be that the *Militär Wochenblatt*, though it has certainly given no overt sign of complicity with the revolution, has been considered too sympathetic with the reactionaries for its publication to be tolerated any longer. For an excellent account of the latest revolution the June number of *Blackwood* is recommended.

L. CHENEVIX-TRENCH, *Major, R.E.*

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REVUE MILITAIRE GÉNÉRALE.

January. 1920.

Army reconnaissance in the single seated aeroplane.—By Capt. P. Weiss. An argument in favour of using the light, swift, single seated aeroplane for gathering intelligence for the army command. When it is not a question of obtaining accurate photographs for the guidance of the troops in the front line, for which the heavier two-seater is more suitable, but of gleaning information and reporting rapidly on movements in the enemy's rear, such as concentration of troops or material, or movements of troops from one sector to another, the small swift machine is most useful. Owing to its lightness it can remain over one spot until the pilot has absorbed accurate details of all he sees and what it implies, and owing to its speed it is fairly safe from attack from the ground and can descend to verify details not fully comprehended from above, or screened by clouds. The pilot, since he is also observer must receive special training. His reports are verbal, and if he is not certain on any point the qualities of the machine enable a fresh journey to be quickly completed.

GERMAN OPINIONS OF THE WAR.

Deductions from the World War (continued).—Reasons are given to explain why the Germans did not anticipate much bayonet fighting. The war has re-introduced hand grenades and mining, and has given birth to flame throwers, bomb throwers, trench mortars of an improved pattern, the increased use of machine gun, gas warfare, and tanks. The use of indirect high angle fire by the artillery has been much extended, and it was found impossible adequately to supply ammunition. It is possible that for the future trenches strengthened by barbed wire screens will replace fortresses, except perhaps in situations where defensive tactics alone can be employed. Large towns will certainly not be fortified, but certain frontiers may have to be defended by a succession of permanent forts, connected by other works to be erected on the declaration of war. Attack is still the best defence, but " the war has disclosed the immense strength of a defence based on well-constructed fortifications, on account of the efficacy of modern weapons, and this revelation, taking into consideration our central geographical position, is of great value."

IV. Leadership.—In the case of leadership the intellectual element is important. The lessons of earlier wars must be applied with due consideration of their applicability to present conditions. The corps of 1866 and 1870 has now attained the dimensions of the army of those days, and the difference between the warlike appliances of 1870 and those of the Napoleonic wars was less great than now exists between our modern appliances and those of 1870. Peace exercises give no conception of the effect of firearms at the commencement of a campaign. Again the improvement in firearms has resulted in a wide extension of the battle-front. Armies of the strength of those employed at Koniggratz now occupy four times the space. Field Marshal von Schlieffen realized these

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points, and our successes in the war are due in great measure to his efforts in training the General Staff to a war of masses. Up to the Marne our exploits were brilliant, then the wastage of war made itself felt. Moltke's forces were at the beginning of the war of 1870 to the French forces in the proportion of 5 to 3. In 1914 the German forces on the French front were slightly less than the French alone, and counting the Belgian and British forces the deficiency was 750,000 men. Our intention had been to envelop both flanks, the envelopment of the French right was checked by their frontier defences, that of their left by a menace to our own right. The French were acting on interior lines, and their admirable system of railways and roads enabled them to reinforce their front quickly. If they had utilized these to the utmost after the battle of the Marne they might, by attacking our right flank, have prevented the establishment of our position on the Aisne.

A. R. REYNOLDS.

REVUE MILITAIRE SUISSE.

No. 2.—March, 1920.

THE EVOLUTION OF THE BATTLE OF THE MARNE.

The original article is by Colonel Poudret, who points out that critics of Marshal Joffre continue to make themselves heard. Work upon work is being issued from the press, some written in a tone of moderation —as for example General Le Gros's *Genèse de la bataille de la Marne*— others in a spirit of excessive violence; the latter savour of the opening speech of a prosecutor and contain serious indictments against the French Higher Command, which is alleged to have been responsible for the incompleteness of the system of fortifications existing in France at the outbreak of the late War; the faulty initial concentration; the premature offensive operations in the early stages of the War; the precipitate abandonment of territory after the battles on and near the frontiers; lastly, an attempt is in some cases made to prove that the credit for the stand made on the Marne which has been generally attributed to Marshal Joffre has been so attributed erroneously and that the credit really belongs to others, particularly to General Gallieni, the Governor of Paris. Colonel Poudret points out that in the criticisms which have been levelled against the French Higher Command allowance is not always made for the fact that decisions had necessarily often to be taken on the meagre information at hand at the time the particular problem was under consideration; it was inevitable that in certain cases orders had to be issued and action taken on incomplete and even uncertain information. Colonel Poudret sets out the case made in favour of General Gallieni by those who advocate his cause and also that made on behalf of Marshal Joffre by the latter's partisans; he also touches upon some of the more important points in relation to this matter dealt with by General Le Gros in his recent work. He is of opinion that in spite of faults in the conduct of the initial stages

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the campaign on the Western Front attributed to "père Joffre," the French generalissimo of 1914 stands out for all time as one of the veritable Grand Men of War.

THE RÔLE OF ENGINEER TROOPS IN THE WORLD WAR.

The original article is from the pen of Colonel Lecomte, who points out that it would be premature to attempt to deduce, from the incomplete information available at the present day, a complete theory of modern war under the latest conditions developed in the recent great conflict of arms. In the late struggle science and industry came handsomely to the aid of the fighting man and put all their resources at his disposal in the most complete manner possible. An immense wealth of technical appliances, etc., were placed at the disposal of the military engineer during the progress of the war. Engineer troops had thus an opportunity of performing a great variety of services, and taking advantage of it, played a most important rôle in the Great War. Many novel and special spheres of activity had to be assigned to the engineer troops in every one of the belligerent armies throughout the whole duration of the war; they did what was necessary in each case to develop these novel and special services up to the pitch of practicability. Having been brought into effective working order by the engineers, the new services were, in many cases, transferred into other hands for practical application, whilst the engineers turned their attention to yet further new fields of technical development. Colonel Lecomte classifies the duties undertaken by Engineers in the late War as follows:— 1. Construction and destruction of communications. 2. Entrenchment of the field of battle. 3. Laying out of encampments and cantonments and services in connection therewith. 4. Co-operation with the other arms in the actual fighting.

The duties as arranged above are in their relative order of importance according to the conception of Lecomte, who gives the reasons which have led him to adopt the foregoing classification and to assign to each group its position in the list. An extract is given in the original article from the instructions issued to the French Army in 1917 regarding the functions of engineer troops in the combat; the rôle of these troops in a modern war is also succinctly described. (*To be continued*).

ERICH LUDENDORFF.

The original article is contributed by Colonel Feyler; he very briefly traces the psychological evolution in Napoleon in relation to his outlook on military problems as a Commander-in-Chief; the Great Captain of cool calculation, he tells us, by reason of a too absorbing ambition, intensified by sustained success in war, developed, in time into an inveterate gambler ready to accept every risk, however hazardous.

Readers of the Memoirs of General Ludendorff as they ponder over the events, from the capture of Liége in August, 1914 to the armistice of November 11, 1918, in the career of Hindenburg's Quartermaster-General are from time to time reminded to some extent of the Great

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Corsican's career; not that these two personages are, as Colonel Feyler points out, in any way comparable from the military point of view. Three essential qualities, says Colonel Feyler, were wanting in Ludendorff. If he had the power of cool calculation, he does not seem to have possessed any imagination. If he knew the German soldier, he does not seem to have understood men. If he possessed a competent knowledge of the science of strategy, he does seem to have been acquainted with the art of war. He has not that spark of genius which reanimates science by practical application of its principles, nor does he seem capable of keeping the torch of progressive knowledge burning through trying vicissitudes by the creative action possessed by those of great personality. Colonel Feyler shows that the foregoing shortcomings narrowed Ludendorff's outlook on the problems with which he had to deal and were largely responsible for his failure to appreciate in their true perspective the various elements that entered into combination, a failure which led eventually to the defeat of the German hosts.

Notes and News.

France.—A special correspondent refers to the debate in the French Parliament in relation to the calling up of the recruits of the 1920 class. The questions which have created most interest in relation to Army matters were those connected with the duration of the period for which the recruits should be called up and that of the period for which they should remain with the colours. It is generally accepted that three years is too long a period nowadays to withdraw youths from civil life for the purposes of a preliminary military training; there are some who argue that 8 months would suffice in which to train recruits, but the French General Staff is of opinion that recruits should be called to the colours, in the first instance, for one year. This question has been remitted to a Committee, under the presidency of General Castlenau, for investigation and report. The opinion seems to be widely held that Germany is already making active preparations for a War of Revenge and that for this reason no precautionary measures should be neglected which tend to checkmate German designs in an incipient stage.

Bibliography.

Notices are published relating to General Percin's 1914 *Les erreurs du haut commandement*; Viri's *Nation Armée*; Choisy's *La question balkanique devant l'opinion suisse*; and Puaux's *La Grèce.*

W. A. J. O'Meara.

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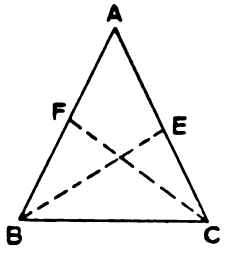
PROBLEMS.

PROBLEM 9 (Proposed by Lieut. R. H. Nisbet).

A triangle ABC is such that the lengths of the bisectors BE, CF of the angles ABC and ACB are equal. Prove that AB=AC.



PROBLEM 10 (Proposed by Lieut.-Colonel J. M. Wade).

A corkscrew is held with its axis at right angles to a horizontal table, under what circumstances is the shadow of the screw, thrown by the sun on the table a cycloid ?

Problems 1 *to* 8 *have appeared in the recent issues of "The Supplement to the R.E. Journal."*

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THE FUTURE OF TANKS.

By CAPTAIN AND BT.-MAJOR G. LE Q. MARTEL, D.S.O., M.C., R.E.

MANY papers and books have been written on the subject of tanks, but in nearly every case they have dealt with tanks in their present form or tanks in their immediate future. The tank referred to is always the bullet proof tank which can be compared with the destroyer in the Navy. Though both heavy tanks and light tanks were used in the war they were all of one class—the bullet proof class; other classes of tank which should be proof against shell fire were discussed during the war but did not materialize, and it was with the intention of collecting ideas as to the eventual future of tanks that the following notes were written by the author some three and a half years ago. It is not likely that any nation will be allowed to build a large tank army in peace time, but experimental tanks will be constructed and tanks will probably be used in small numbers for police work. If then we are eventually launched into another great war the fighting will probably again relapse into trench warfare, but the next stage will be a battle between the tank armies of both sides. The nation which can produce the largest and most efficient tank army in the shortest time will have an overwhelming advantage against its enemies. The closest co-operation will be required between the air force and the tank armies, but this subject is not referred to in these notes, which only deal with the methods of fighting and types of tank required. A certain amount of detail has been given as regards size of guns, speed of tanks, etc., with a view to producing a more realistic picture of what the future tank armies may eventually resemble; these details may prove to be inaccurate, though the latest types of tank have reached the specification laid down for the "destroyer tank" in most respects. As the construction of a "destroyer tank" has very nearly been achieved (and this was considered impossible at the time these notes were written), there would seem to be no reason why the other classes of tank should not eventually materialize. A discussion on this subject would be of interest.

TANK BASES.

All tanks will operate from a tank base. With the British Empire, these bases will be established in all our foreign possessions and

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colonies, and in certain centres of the United Kingdom. A continental country, such as France, would establish bases near her frontier. Her tank armies would mobilize at these points, which would be some fifty miles behind her frontier, and about a hundred miles apart, and all operations would be carried out from these bases. Any tank base will be strongly defended against tank attacks. Wire entanglements will disappear as an obstacle in tank warfare and in their place we shall find any or all of the following, which would be constructed all round the tank bases :—

(1) A trench impassable to tanks.
(2) Continuous land mines.
(3) Pillars of wood or concrete sunk deep into the ground in a vertical position and projecting several feet from the ground, thus making an artificial forest of strong tree stumps.

The bases will also be protected by a tank garrison and probably by a fixed armament.

The whole object of the tank armies will be the destruction of the enemies' tanks. As the armies approach for the battle they will have to form advanced bases for stores and workshops, which will have to be very closely guarded. All stores will have to be convoyed from the bases to the advanced bases, as tanks have great powers of raiding. Railways will be particularly difficult to guard for this reason.

TYPES OF TANKS.

Excluding the specialist services such as the signal tanks, and the supply tanks, there will be three arms of the tanks :—

(1) The Destroyer Tank.
(2) The Battle Tank.
(3) The Torpedo Tank.

The destroyer tank will be the main arm of the service. It will do the present duties of the infantry and cavalry, and will have to fight the enemy tanks at close quarters and kill or capture his men. It will depend mainly on speed for its protection.

The Battle Tank will be used chiefly to strike the enemy's tanks from a distance, and to cover the advance of its own tanks.

The Torpedo Tank will be used solely for the destruction of the enemy's battle tanks. Let us now consider each type of tank in turn.

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The Destroyer Tank.—The duties of this tank will be :—

(1) The destruction of the enemy's small tanks and the eventual destruction or capture of his men, his bases and all warlike stores.
(2) The defence of his own lines of communication and bases, and the defence of his battle tanks against the enemy's torpedo tanks.
(3) Reconnaissance and contra-reconnaissance work.
(4) Raiding.

Speed and large radius of action are essential ; the weight and hence the armour will have to be light, and it will not be possible to make the armour in any way proof against the fire from a similar type of enemy tank at close quarters. The efficient performance of the duties of a destroyer tank will therefore depend on :—

(1) Accurate and rapid fire against enemy tanks with a light gun.
(2) Speed.
(3) Making use of cover.
(4) Covering fire from Battle Tanks.

This tank will therefore be armed with one light automatic gun firing an armour-piercing shell and firing from the front of the tank. It will also be armed with one Lewis gun on either side for the destruction of men. The armour will be about ½ inch thick and be proof against armour-piercing bullets. A maximum speed of 20 m.p.h. should eventually be reached on level ground with this type of tank.

The Battle Tank.—The duties of all Battle Tanks will be the destruction of enemy tanks (usually from a distance) and covering by their fire the destroyer tanks. There will be three different types : light, medium and heavy.

(*a*) Light Type.—This type will have armour 1½ inches thick so as to be proof against the fire of the enemy destroyer tanks. It will be armed with a 3-inch gun firing armour-piercing shell and mounted in the front part of the tank. A light automatic gun will fire from each side of the tank for use against the enemy's destroyer and torpedo tanks. Duties :—

(1) Destruction of enemy small tanks.
(2) Destruction of enemy tanks of the same type as itself, which are holding up the advance of our destroyer tanks.

This type should attain a speed of 8 m.p.h.

(*b*) Medium Type.—This will be the mainstay of the battle class. It will have armour from six to eight inches thick. Each tank will

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be armed with one.6-inch gun in front, and one light automatic gun each side as a protection against attack by enemy torpedo tanks. Its speed will probably be only two or three m.p.h. The duty will be the destruction of every type of enemy tank.

(*c*) Heavy Type.—The duties of this tank will be :—

(1) Destruction by shell fire at a long range of the enemy's bases, workshops and stores.
(2) Bringing shell fire to bear from a long range to any point where the enemy is assembling his tanks.
(3) Counter battery work on similar tanks belonging to the enemy.

In order to carry out these duties, this type of tank will require a howitzer of very big calibre.

A 12-in. howitzer will probably be the most suitable weapon. It would fire a H.E. shell. The armour will be merely splinter-proof, say half-inch thick, as it would be impossible to keep out a direct hit from the shells fired at it from a similar type of enemy tank. It would be protected by an escort of destroyer or light battle tanks. This type of tank could take very little part in an action until the enemy has established himself at some point or been driven back on his base. The speed of this tank would only be about 2 m.p.h.

The light and medium battle tanks would use direct fire almost entirely ; the heavy battle tank would use indirect fire.

The Torpedo Tank.—The duty of this tank is the destruction of the enemy battle tank. It will carry a torpedo-tube which will fire straight to the front. This tube and the ammunition will be similar to the present big trench mortars. The tank will carry five torpedoes, which will weight about 100 lbs. each ; it will also carry one Lewis gun. The success of this tank will depend almost entirely on the speed, which would be about 30 m.p.h. on level ground. The tank will be armoured with ½-inch armour plate and will be constructed as light and small as possible. The torpedo tank will probably have to operate by night or under cover of a smoke barrage. It will advance towards the battle tanks, using its speed and all existing cover, and will fire its torpedoes from a range of about 500 yards.

TACTICS.

The opposing armies leave their bases and manœuvre for position. The destroyers of the one side go forward at once to get in touch with the enemy and endeavour to destroy his destroyers. They are closely supported in this by light battle tanks. The medium battle tanks then arrive and engage in battle. When one side begins to gain the advantage and the enemy's screen of destroyer tanks is

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broken, the torpedo tanks are launched to destroy the enemy's battle tanks. The enemy is then forced to retire to his defended base. Meanwhile the heavy battle tanks have been arriving. They may take part in the later stages of the fight, or they may not be used till the enemy is surrounded or driven back to his base in which case they would very soon bring about his surrender.

Organization.

The whole tank force will be organized in two or three armies. Each army will be organized in corps and divisions. Heavy battle tanks will be corps troops. Medium and light battle tanks will be divisional troops. A division will have one wing of destroyer tanks. This wing will consist of four squadrons, and each squadron of four groups of five tanks each. A division will also have one squadron of torpedo tanks organized in the same way as the destroyer tanks.

Headquarters.

Headquarters will fight as follows :—

Army Headquarters—at advanced bases.
Corps and Divisional H.Q.—in unarmed tanks with 8-in. armour and protected by an escort.
Wing Headquarters—in unarmed tanks of the destroyer type.
Brigade H.Q. of Battle Tanks—with their Division or Corps H.Q.
Squadron H.Q. Destroyers—in the ordinary destroyer tanks.
Squadron H.Q. Torpedo Tanks—in ordinary torpedo tanks.

Branches of the Tank Army.

Just as there are specialist branches in our present army, so there will be specialist branches with special tanks in the tank army. These branches will be :—

(*a*) Royal Engineers.
(*b*) Signals.
(*c*) Supplies.
(*d*) R.A.M.C.

We will take these in turn.

Royal Engineers.—The Royal Engineers will require tanks of the destroyer class to go with the destroyer tanks and their duties will be :—

(*a*) To destroy enemy railways, bridges, etc.
(*b*) To remove tank obstacles, natural or artificial, which the destroyers might meet.
(*d*) To construct tank obstacles.

These tanks will have approximately the same speed and armour as the destroyer class, but will be armed with one Lewis gun only

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in front. The Royal Engineers will also require supply tanks such as those described below, to carry tools and materials for constructing and removing tank obstacles.

Mechanical excavator tanks will also be required for making cuttings through very steep banks and also for digging tank obstacles.

Signals.—An efficient signal service between the three arms of the tank army will be of utmost importance. Every tank in the army will be equipped with a signalling lamp for use by day or night up to five miles. Communication between the fighting tanks will be mainly carried out by means of these lamps. Each Squadron Commander will have a special wireless tank for communication with his Wing Commander, and communication between all headquarters will be maintained by these wireless signal tanks.

Supplies.—Supply tanks will not be armed or armoured. They will only have a thin steel covering to keep off splinters. They will be all of one type except that the details of the body work will be altered to suit the stores they have to carry. They will carry a load of five tons and will travel at 15 m.p.h. Supply columns will generally have to be escorted. Their duty will be to supply every type of tank with food, fuel and ammunition. Lorries (probably with the vital parts armoured) will be used in the back areas.

Workshops.—Each wing will have one workshop, consisting of eight tanks of the destroyer class. These tanks will be unarmed and will carry fitters, spare parts and hand tools only. They will be used to give first aid to all destroyer tanks, and will save the destroyer tanks having to carry a large number of spare parts and tools.

In addition to this wing workshop there will be a division workshop, which will have one section for the repair of each type of tank. This workshop will consist chiefly of tanks of the supply type, carrying fitters, hand tools and spare parts ; a few light lathes and drilling machines, etc., will also be carried.

There will be extensive workshops at the advanced base and the base. Tanks will return there for their periodical overhauls and for all extensive repairs.

R.A.M.C.—The R.A.M.C. will have ambulance tanks of the supply type for conveying wounded to the collecting stations, where they will be transferred to motor ambulances.

GENERAL DESCRIPTION.

Every tank will be made water-tight, and have a small screw at the back so that it can float and be propelled slowly across a river.

The smaller tanks will almost certainly be driven by petrol engines, but the larger type might be propelled by steam.

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NOTES ON THE RE-ORGANIZATION AND TRAINING OF INDIAN SAPPER AND MINER FIELD COMPANIES FOR MODERN WARFARE.

By CAPT. H. A. JOLY DE LOTBINIÈRE, M.C., R.E.

THESE remarks are primarily intended for R.E. officers at present serving with S. and M. Companies abroad, and are the outcome of the writer's personal experience during the War, and the result of conversations with other Company Commanders. At the same time it is hoped that they may prove of interest to officers on the British Establishment who have to contend with some of the problems which confront his Indian *confrère*.

The Indian Sapper and Miner Companies as organized at present are intended principally for mountain warfare on the frontiers of India against an uncivilized enemy; as such, their present equipment and transport are admirable. In the future, however, Indian Field Companies may be employed in countries like Asia Minor, Syria, or Africa, and against troops trained in modern warfare. To meet these conditions the present organization needs remodelling.

The main factor in introducing any changes is the matter of expense, and any ideas involving a considerable outlay will most certainly be impracticable at the present time; so that the present war establishment cannot be materially altered, or any drastic changes in equipment and transport be considered.

I propose dealing with the various points under separate headings and will commence with :—

A.—PERSONNEL.

The main difference between the Indian and British company is that the former instead of being one homogeneous unit like the latter, is composed of at least two separate and distinct races as far apart from each other as regards religious differences, as the Catholic Sinn Feiner is from the Protestant Orangeman. This in itself is a difficult proposition to deal with; but when we have two separate classes amongst the men of one sect—the yeoman farmer or *zemidar* who forms 95 per cent. of the pioneer element in the unit, and the skilled artisan or *mistri* who takes the place of the tradesman in a British unit—the question becomes further complicated.

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As matters are at present the unskilled farmer looks down on the village carpenter or blacksmith as being practically his servant in the villages; such being the case, artificers make poor N.C.O.'s and Indian officers as a rule, and in consequence stand a poor chance of promotion—which certainly affects their recruiting. The suggested remedy for this state of affairs will be dealt with later.

The organization of the Field Company is the 4-section (or platoon) system, but with no headquarters section, a most serious defect. Although in 4 sections the company is actually divided up into half companies in the matter of equipment, etc., and no cut and dried section organization exists, as in a British unit, which can send a section away at a moment's notice. These half-companies are, as a rule, composed of men of one caste, *e.g.*, Pathans, or Panjabi Mussalmans and Sikhs, Mahrattas or Hindus. Recently the three-caste system in one unit has been introduced to facilitate the matter of reinforcements, a most difficult problem; but from the C.O.'s point of view it is not an ideal arrangement by any means.

In the recent campaigns in Mesopotamia and Palestine where troops operated over large areas, and units were naturally scattered, it was found essential to break up the companies, usually with a half company and two sections in separate localities; but occasions occurred when all four sections were separated.

Owing to the shortage of skilled artificers, and to the caste system, it often resulted in sections being sent away with practically no tradesmen, thereby greatly reducing the efficiency of the section. This was partially obviated by transferring men from one section to another (within caste half-companies), but the defects of this will be apparent to all.

To meet this great difficulty it is suggested that a headquarter section be formed, containing all the artificer ranks of the unit. These would be roughly divided into equal portions of Hindu and Mussalman. The remaining four sections would contain all the pioneer ranks of the unit, that is to say sappers who have been taught the elements of carpentry and blacksmiths' work during peace time in barracks.

General Thuillier in his lecture at the S.M.E. suggests the proportion of sappers to pioneers as 1 : 3, or 25 per cent. of artificers in the unit. This principle applied to an Indian unit would mean that out of a war establishment of 150 sappers, 38 would be artificers and 112 pioneers. In adopting however the 5 section organization, it is proposed to keep the original number of sappers (artificers and pioneers) as at present, *i.e.*, 150, and to make each section 30 strong, excluding N.C.O.'s.

The advantages claimed for this system are that when a section is ordered away, the needful artificers can be attached to it whilst it is away from H.Q. Only such artificers as would be specially

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needed would be sent, and if any particular work was being undertaken by the section, such as building, all the masons of that caste could be sent, without in any way upsetting the section organization as happens at present. Whilst at Headquarters all the artificers could be employed in the company workshops or on special works.

This system would keep the artificers and pioneers apart as regards promotion, and enable men of the former class to rise to the rank Havildar, and Havildar Major. The standard of the artificer must be considerably raised in order to cope with the technical work a company is called on to perform nowadays. If this is to be done, men must be attracted to the service by higher rates of engineer pay, and better chances of promotion. At present engineer pay is woefully inadequate for artificer ratings, and a man can earn far higher wages in civil life ; and the result is that in war-time all the best men enlist in the hastily raised Labour Corps, who pay high rates for skilled artisans.

It is suggested that in every company there should be at least 3 " A " rate artificers, and 4 men trained as petrol engine drivers and fitters. At present the latter are almost non-existent. Special care should be taken in peace time to teach artificers the erection of pumping-plant, engines, etc., and repairs to same—as companies will frequently be called upon to execute this kind of work in the field.

The alternative to this suggestion would be to have three companies organized as at present, and to have an R.E. Headquarters (Works) Company or large section ; or, as was done in the Egyptian Expeditionary Force, have 2 S. and M. Companies brigaded with 1 British company, the latter remaining with R.E.H.Q. and acting as a Works Company. The objection to both of these suggestions is the expense entailed.

The following further changes in *personnel* would appear advantageous :—

(*a*) *Officers*.—During the war the War Establishment was raised from 4 R.E. officers to 5, but even this increase is not sufficient. Experience proves that there must always be someone at Headquarters to deal with correspondence, administration, animals, etc. This cannot be one of your section officers, who should be with his section on work—a most necessary proceeding—for an Indian officer or Section Havildar can rarely be given a plan or sketch, and be relied upon to carry on without a British officer to supervise his work.

In consequence, whenever the C.O. has to spend the day reconnoitring a position with the brigade or with his C.R.E., or choosing suitable sites for a water supply, etc., he often returns home at the end of a long day to find 3 or 4 hours of strenuous office work ahead of him, as, with the quality of soldier clerk provided at present, the brunt of the office falls on the C.O., which is no small task when one recollects

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the enormous numbers of returns alone that have to be compiled, to say nothing of company accounts, etc. Indian officers are useless for this kind of work, and British N.C.O.'s are not intended to be employed as clerks.

Apart from office work, there is at present no particular officer to whom one can allot the care of equipment, stores, rations, animals, clothing. As a rule, this work devolves on the next senior officer, who is a Section Commander, in addition to his other duties, and who is expected to go on work like the other officers of the unit. As a result, his extra duties suffer, and when most wanted, he finds that he has to proceed on detachment with his section, leaving his work to be done as a rule by the O.C. Unit. Such a state of affairs would never be tolerated in a British unit, but it is what most C.O.'s of Indian units have had to face during the War.

The obvious solution to this is to increase the War Establishment of British Officers to that of a British unit, thus giving the C.O. a Captain at H.Q. who would be entirely responsible for the aforementioned duties, leaving the C.O. free to concentrate entirely on his proper job, and at the same time ensuring that the Section Officers really are section officers in the same sense that a Platoon Commander really does command his platoon. It is certain that the interior economy of the unit would run more smoothly than at present, and certainly the care of the transport and upkeep of equipment would greatly benefit, by this arrangement.

(*b*) *British N.C.O.'s.*—All O.C.'s S. and M. Cos. will agree that two properly trained and efficient R.E. N.C.O.'s increase the efficiency of the unit enormously. They are so to speak the link between the officer and the tradesmen. With the tremendous amount an R.E. officer is supposed to know these days, it is almost impossible for him to be an expert in carpentry, or blacksmiths' work ; thus the position of a British N.C.O. is two-fold. Firstly, he is the technical adviser of the C.O. when professional knowledge of various trades is required ; and secondly, he supervises the work and training of the artificers.

On service it is usual to employ one of these N.C.O.'s in the capacity of C.Q.M.S., in fact to a certain extent he performs the duties of the Company Captain. This means that only one British N.C.O. is left to both supervise the work in the company shops, and at the same time to go out on to any works where his superior technical knowledge is required. This means a loss of efficiency, which could be avoided by increasing the War Establishment by one R.E. N.C.O. This would give the O.C. two British N.C.O.'s for works entirely, and would leave one other to understudy the Company Captain, and to assist him by drawing rations and making out indents, etc., for engineer equipment. Men with some knowledge of machinery and fitters' work should as far as possible be posted to Indian companies.

(*c*) *Indian Officers.*—The present establishment of 4 is thought

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sufficient, though to bring them up to a level with the infantry it is suggested that the half-company Indian officers should both be Subadars, instead of one Subadar and three Jemadars as at present. The Company Havildar Major would remain at H.Q. and act as Indian officer to the H.Q. section, which would be under the Company Captain.

(*d*) *Indian N.C.O.'s. Havildar Establishment.*—For the H.Q. section one artificer havildar is suggested, in addition to the C.H.M. and the C.Q.M.H., who would always be at H.Q., together with the Driver Havildar; in all, 4 havildars at Company H.Q. With the sections would be 4 section havildars: in all, 8 havildars; no increase to establishment being incurred.

Naik Establishment. At. H.Q. 2 artificer naiks are recommended, and also 1 engineer equipment naik, and 1 quartermaster's naik to take charge of stores and rations. At present these last two highly responsible posts are held by lance-naiks, who, as soon as they become thoroughly conversant with their work, are generally promoted naiks, or if not promoted are passed over as being too useful to leave their appointments; thus making these responsible appointments thoroughly unpopular amongst the budding N.C.O.'s of the company, who see in them the grave of their ambitions. The driver naik would also remain at H.Q. as a rule, unless half a company was sent on detachment: making in all 5 naiks at H.Q. For the Sections 2 squad commanders are sufficient: making in all 13 naiks as against 11 at present authorised; an increase of only 2.

(*e*) *Indian Other Ranks.*—It is suggested that in addition to the N.C.O.'s enumerated above, who are part of the H.Q. section, the following be added:—2 fully qualified farriers, 1 being unable to cope with 113 animals; 1 wheelwright; 1 ward orderly; 2 clerks. The 2 buglers authorised are quite unnecessary; thus the total increase to present sapper establishment would be 1 farrier and 1 wheelwright.

With the driver establishment should be 8 spare sapper drivers to act as grooms and horseholders. At present no grooms are authorized and as it is usually impossible to obtain private *saises*, it means that the working strength of the unit is depleted to provide these men. Of these 8 men, 6 would be for officers' horses, and 2 would be for the horses of the 3 British N.C.O.'s and the S.A. Surgeon.

(*f*) *Followers.*—These notes will not attempt to deal with the question of private followers, a burning one, which concerns the whole of the Indian Army on service, except in so far as the grooms mentioned above are concerned.

An establishment of 5 sections instead of 4 would mean an additional sweeper and *bheesty*—a fifth cook already being allowed, presumably to meet the needs of the 3-caste system. This increase would be balanced by the decrease of 2 *saises*, for the British N.C.O.s' horses mentioned above.

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It is suggested that these 16 followers be armed and trained sufficiently to take a hand in cases of emergency. They would assist in decreasing the baggage guard, always a drain on a company's working strength. They would form part of a properly enlisted corps, and be treated not as menials but as soldiers. This would greatly increase the self-respect of these classes in the Army, besides increasing their discipline and usefulness.

The following table will show the suggested alterations in the War Establishment of a Field Company, S. and M., as compared with the authorized establishment of a company in the E.E.F. (shown in brackets.) The table shows an increase to War Establishment of 5 sapper ranks and 8 driver ranks; surely not too great a concession for the increased efficiency obtained, especially as the 8 driver ranks would have to be found from amongst either the sapper establishment or the attached S. and T.C. transport in any case.

B.—EQUIPMENT.

(*a*) *Engineering.*—It is not possible in the space of these notes to more than touch on one or two salient points regarding the alteration of the present scale of equipment laid down.

Assuming that the present method of carrying engineer equipment in 80 lb. loads in boxes, etc., is retained, it is suggested that all the second line loads (32 in number) be made part of the H.Q. equipment—the 4 sections retaining their present equipment consisting of 4 loads each, of 20 picks and 20 shovels, mining and demolition gear. When sections are ordered away from H.Q., such loads of second line equipment as are specially required could be sent with the section, the senior artificer sent with them being made responsible for their care.

Of the 32 second line loads, it is suggested that loads 49 and 50 (wrappers, canvas and mule rugs) be altered, and loads containing stocks and dies up to 4 in. for pipe work and pipe cutters, be substituted. These latter, though not actually authorized by M.S.T., were usually carried by companies, the result being to add to the weight on already heavily loaded waggons. The present loads could easily be distributed amongst the waggons of the unit, and on the spare mules and horses.

Two loads of saddlers' and tinsmiths' tools appear unnecessary, and were never carried in the writer's company; one load being amalgamated, thereby saving one mule, upon which it is proposed to carry a level, an instrument frequently required and seldom available in S. and M. units. Some better method of dividing up the carpenters' tools into 4 boxes should be adopted, thus enabling each section to be sent away fully equipped. The number of 26-in. handsaws too, need increasing from 10 to at least 20.

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	B.O's.	B.N. C.O's.		Total I.O's.	I.O.R.'s.	Drs.	Total.	Public Followers.	Remarks.
British Officers ...	6 (5)								
B.N.C.O.'s ...		3 (2)							
I.O.'s and S.A. Surgeon ...				5 (5)					
Havildars ...					7 (7)	1 (1)			(*a*) At present included in total of 150 sappers.
Naiks					12 (10)	1 (1)			
Sap. Artificers ...					30 (*a*)				
Sap. Pioneers ...					120 (150)				
Drivers						26 (18)			
Clerks					2 (*a*)				
Ward Orderly ...					1 (*a*)				(*b*) Includes 1 B.N.C.O.'s cook.
Farrier					2 (1)				
Wheelwright ...					1				
Buglers					(2)				
Cooks								6 (6) (*b*)	*Note.*—2nd Line Transport *personnel* and private followers are not shown.
Bheestys ...								5 (4)	
Sweepers ...								5 (4)	
Syces								(2)	
	6 (5)	3 (2)	9 (7)	5 (5)	175 (170)	28 (20)	208 (195)	16 (16)	

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The foregoing alterations do not necessitate any increase in the actual number of existing loads.

(*b*) *Water Gear.*—The issue of water gear to S. and M. units was only recently made, and is not as yet authorized in War Establishments (India). The value of such equipment is obvious to all, and no arguments in favour of its retention need be urged. The present scale in the E.E.F., viz., 12 L. and F. pumps, 8 600-gallon troughs, 4 2,300-gallon tanks, together with pipe wrenches, spare parts and repair material were found to be sufficient. Iron (and not leather) charsas can be carried when troops are operating in a country containing deep wells and cisterns.

This equipment is capable of being divided up into 4 equal loads, for which each of the 4 sections is made responsible, as being part of the section equipment.

C.—TRANSPORT.

The combination of pack and wheel transport authorized for companies in the E.E.F. cannot be bettered for warfare in semi-civilized countries, such as those in which Indian troops may be called upon to operate.

At present 18 1st line mules are allowed, including 2 spares, and 42 2nd line pack mules (including 10 for 1st line transport, *i.e.*, water and ammunition). No spares, however, are authorized for the latter, which means either "dumping" a load when a mule goes sick, or else placing it on one of the company waggons, and thereby overloading the heavy vehicle. Four spare pack mules should be allowed in addition to Nos. 17 and 18. The water gear is normally carried on 4 G.S. waggons (6-horse), and the baggage, stores, etc., on 4 L.G.S. waggons.

The advantages claimed for such a high proportion of pack animals is, that although roads will probably exist along which the baggage of the force can be carried on wheels, yet the water supply and various works will occur in spots inaccessible to wheeled transport. Whenever a reconnaissance has shown that this will be the case the majority of the 2nd line engineer equipment loads can be placed on the G.S. waggons, and the water gear made up into convenient pack loads, and sent off with the sections. This method was adopted by several Sapper companies in Palestine and proved to be highly successful. Tool carts, though more economical in horse flesh and far handier and compact than the numerous pack loads, suffer from the lack of advantages just pointed out.

With the 5-section system, 1 extra L.G.S. waggon for the baggage and stores of the H.Q. section would be imperative, and in addition an extra G.S. waggon for H.Q. stores, mess, etc., would prove invaluable.

Thus it can be seen that under this scheme each section would be

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a self-contained unit, and in nowise dependent on H.Q. for transport, as each of the 5 sections would possess 4 engineer pack-mules, (H.Q. section not included) 2 1st line transport mules, 1 G.S. waggon and 1 L.G.S. waggon.

The 4 spare draught animals and drivers allowed in the E.E.F. were found to be sufficient.

The whole of the 2nd line drivers who are supplied by the S. and T.C. on mobilization should be permanently attached to the unit throughout the whole of the operations. They should be under the command of a Kot-daffadar, and treated in exactly the same way as the sapper element of the company. There is far too much tendency in many units to look down on and belittle the transport drivers, who as a rule do sterling work under very trying conditions. If this was done, better discipline would prevail, and the O.C. company would find a great improvement in the turnout of his transport, and a better sense of discipline and *esprit de corps* amongst his attached *personnel* than usually exists at present.

No increase of *personnel* over and above that laid down for the second line transport establishment in the E.E.F. would be required, except the 2 drivers needed for the 4 spare pack mules, and the *personnel* for the 2 extra vehicles proposed.

If an assistant *salutri* or driver qualified in veterinary work could be attached to each company, he would prove of great assistance to C.O.'s, as the average R.E. officer comes out to India with very little experience of animal management, and it is only after many years of experience that he really becomes qualified to treat a sick horse or mule, which he has frequently to do on service, where veterinary officers are few and far between.

D.—Training.

It is thought that more attention should be paid to the training of men in temporary hutting, water supply and camp drainage than is done at present. This might economically be accomplished by employing sappers on military works when suitable works occur.

Very few Indian sappers (pioneer class) can use the simplest tools with any degree of speed or skill, the prevailing spirit, certainly amongst Panjabis, being to call in an artificer for the most trifling jobs. This is due chiefly to the relations already spoken of existing between the *zemindar* or farmer, and his village artificer. Higher rates of engineer pay might to a certain extent encourage the pioneer to work at his trade, but frequent re-testing for engineer rates would do more than anything to keep a man up to the mark in his particular trade.

The value of constant practice in peace time of night work and getting on to work rapidly and noiselessly, cannot be too greatly insisted upon.

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Among the driver establishment more pains should be taken to teach the men equitation and horse-mastership. This cannot be properly done unless the officers themselves are well versed in horse-mastership, and not merely in riding alone.

At present peace training suffers from lack of officers—2 R.E. officers being the authorized establishment, of whom one officer is frequently away on some course, or else acting as C.O. to another unit, leaving the unit for all practical purposes with only one officer. At present the Company Commander is principally occupied in doing the duties of a C.Q.M.S., pay corporal and clerk ; and in consequence cannot spare any time for real hard training and learning his profession.

Three officers should be the minimum peace establishment of a Sapper company, and in addition each company should be supplied with 2 properly qualified military clerks, who join the unit as trained men, and not as beginners, hardly able to read and write English. This can never be the case until the right class of man is attracted into the service by equal or better rates of pay than he can earn in civil life.

E.—Employment in War.

Sapper companies should not be called upon to perform tasks which the infantry are capable of performing themselves, such as wiring and digging. Sapper companies were often employed on these jobs in Mesopotamia and Egypt ; but this was partly due to the infantry not having been sufficiently trained in peace time to carry out these works, and partly from a lack of material with which to carry out works similar to those carried out by R.E. Field Companies in the line in France.

The writer has primarily intended these remarks for units of the 1st and 3rd Sappers, whose composition include Pathans, P.M.'s, Sikhs, Hindus and Mahrattas ; and not so much for the 2nd (Q.V.O. Madras) Sappers, whose composition more nearly approximates that of a British unit.

The writer also begs to be excused if he has misquoted any numbers, etc., in these notes, but this paper has been written without any of the official text-books to hand.

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THE PROPORTIONING OF CONCRETE.

In the course of the last few years, a great deal of attention has been given—especially in the U.S.A.—to the correct proportioning of the ingredients of Portland cement concrete, so as to obtain a sound concrete of any required strength, at a minimum cost.

The present somewhat rough method of specifying a 1 : 2 : 4, and 1 : 3 : 6 or other mixture will, if the correct amount of water be used, give a strong or weaker concrete with sufficient accuracy where small quantities of concrete are involved, and where the expense of supervising would overbalance any saving in materials.

But where very large quantities of concrete are being placed, considerable economy will result from a more accurate proportioning of the Portland cement, fine and coarse aggregates and added water, in spite of the rigid supervision that is then necessary in order to ensure that the specified proportions are adhered to.

In the construction of roads, carrying heavy motor traffic, it is becoming more and more evident that a water or tar bound macadam has not sufficient rigidity, and that unless the foundation is more than ordinarily unyielding corrugation and pot holes result from the inability of the roadway to properly distribute the concentrated wheel loads. Accordingly, roadways of concrete and reinforced concrete have been and are being experimented with, usually with conspicuous success.

It is found that although the prime cost of a concrete road is rather high, yet the cost of maintenance is so low that taken over a period of years there is generally a very marked saving in the use of this new method of road construction.

In the year 1919 over 4,000 miles of concrete road were in use in the U.S.A. and this length is being rapidly added to.

It is particularly for the purpose of road construction that a table of concrete properties has been got out by Professor Abrams, of the Structural Materials Research Laboratory, Lewis Institute, Chicago, and is now reproduced by the kind permission of Mr. A. N. Johnson, Consulting Highway Engineer, Portland Cement Association (U.S.A.) The use of this table is clearly shown in the explanatory notes which accompany it.

It is necessary to add that at least as much care must be taken in properly proportioning the water that is added to each batch of concrete.

It is found that sufficient water must be used to make the mixture workable, and that such quantity of water is more than enough to hydrate the Portland cement. Any excess of water over the minimum

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required to enable the cement to set and to render the mixture workable, has a marked effect in reducing the final strength of the concrete.

The mixture given by the table would also be suitable for high-class reinforced concrete work, and for mass concrete where impermeability is required. It is hoped that in due course it will be possible to publish additional tables of mixtures yielding concrete of less strength, for more ordinary purposes.

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ABRAMS' TABLE OF PROPORTIONS AND QUANTITIES FOR CONCRETE FOR ROAD CONSTRUCTION.

By A. N. JOHNSON. Consulting Highway Engineer, Portland Cement Association.

The accompanying table shows the various proportions by which to combine a variety of fine aggregates, five selected sizes, with various sizes of coarse aggregates. The fine aggregates, or sands, shown in the table include, first, one with all particles passing a sieve with 28 openings per linear inch and another with 14 openings, one with 8, one with 4 and a sand with $\frac{3}{8}$-inch size particles down. The range of coarse aggregate is apparent from the table.

To determine whether a given aggregate is to be classed as 3-inch or $2\frac{1}{2}$-inch or 2-inch, or whatever the upper limit of size may be, there should be not less than 10 per cent. of the sample between the upper limit and the next lower size. Thus, if a material is to be classed as a 3-inch aggregate there should be not less than 10 per cent. of the total volume of the sample between the 3-inch and $2\frac{1}{2}$-inch sizes; otherwise it will be classed as $2\frac{1}{2}$-inch size. Similarly, if there are 2-inch pieces it will be classed as 2-inch aggregate if there is not less than 10 per cent. between $1\frac{1}{2}$-inch and 2-inch sizes.

For fine aggregates there should be of the coarser material not less than 15 per cent. between the coarser size and the next smaller screen opening. Thus, if a fine aggregate is to be classed as $\frac{1}{4}$-inch size there should be not less than 15 per cent. between the $\frac{1}{8}$-inch screen and the $\frac{1}{4}$-inch screen.

With the $\frac{1}{4}$-inch sand down, the one usually specified, and with the coarse aggregate varying from that held on a No. 4 sieve to that passing a $1\frac{1}{2}$-inch opening, the usual proportions of 1 : 2 : 3 were taken and, with a workable plasticity or practical consistency, such a mixture produces a concrete with a crushing strength at 28 days of 3,000 pounds per square inch in the form of 6×12 inch cylinders. All of the other proportions and combinations are computed to give the same strength concrete as the 1 : 2 : 3 mixture.

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The table is based upon the results of a number of years' investigations by Professor D. A. Abrams of the Structural Materials Research Laboratory, Lewis Institute, Chicago, and is founded upon the general principle which his investigations have established, namely: that the strength of a concrete mixture depends primarily upon the ratio of the amount of water to the amount of cement. The smaller the amount of water that can be used and at the same time produce a plastic or a workable consistency, the stronger will be the concrete.

A variation in the grading of aggregates produces a variation in the strength of the concrete merely because the different gradings to produce a similar consistency or plasticity will require different amounts of water with a given amount of cement. It is thus that the grading affects the resulting strengths of concrete; but in all of the combinations or mixtures shown in the table the cement factor is varied with the variations of the aggregates used so as to produce a constant strength concrete.

It should be noted that Professor Abrams' investigations have demonstrated that the resistance to abrasion varies according to the compressive strength of the concrete.

The practical application of this table is apparent. It shows that a wide variety of fine and coarse aggregates may be combined so as to produce the same strength concrete, and, therefore, makes it practicable to use many supplies of materials not at present available under most specifications which confine the sizes to be used within narrow limits.

Practically all state highway specifications require that the sand or fine aggregate shall vary from ¼-inch down and that the coarse aggregate shall vary from ¼ inch to 1½ inches and in some cases as large as 3 inches. The table, it will be noted, includes very many other selections.

In all cases it is to be assumed that all aggregates that are to be used irrespective of size or grading are to be of material, structurally sound, clean and free of organic impurities.

The table contains in the upper line of each block, the proportion of cement, fine and coarse aggregate to be combined, while immediately below in each square are given the quantities that are required for a cubic yard of concrete, the cement quantity being given in barrels and hundredths of barrels and the quantities for fine and coarse aggregates being given in hundredths of cubic yards.

It should be borne in mind that the quantities shown in the table are for a cubic yard of concrete as determined from laboratory measurements, and that for the purpose of ordering materials or making estimates of the total cost of materials for a given piece of work these quantities should be increased from the amounts shown by such estimate of waste for the aggregates as experience in handling the work, according to the particular method to be employed, has indicated as necessary.

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The following example will make clear the use of the table :—

It will be supposed that one sand is that usually specified, from ½-inch down, and must be shipped in at a cost of $2 per cubic yard and that one coarse aggregate, varying from ¼-inch to 2 inches, must also be shipped in at a total cost of $3 per cubic yard ; that there is available locally a supply of sand and coarse aggregate, each being rather fine, the sand varying from ⅛-inch down which costs $1·50 per cubic yard, while the coarse aggregate varies from ¼-inch to 1 inch and may be secured at a cost $2·50 per cubic yard. The cement in each case is assumed to cost $3 per barrel. The cost of a cubic yard of concrete using the materials to be shipped in would then be as follows :—

1·52 barrels cement	@ $3·00 =	$4·56
·43 cubic yards of sand	@ $2·00 =	·86
·81 cubic yards of coarse aggregate ...	@ $3·00 =	2·43
Total cost of materials for 1 cubic yard concrete		$7.85

Using local materials the cost would be :

1·72 barrels cement	@ $3·00 =	$5·16
·46 cubic yards of sand	@ $1·50 =	·69
·66 cubic yards of coarse aggregate ...	@ $2·50 =	1·65
Total cost of materials for 1 cubic yard concrete		$7.50

Thus the local aggregate, in this instance, although fine and requiring more cement, will produce a yard of concrete at less cost. In general it will be found that the use of finer sand or finer aggregate increases the amount of cement, the opposite being true for coarser sizes. Thus a coarse aggregate with all of the fine material removed, varying from 1 inch to 3 inches in size, combined with sand varying from ¼ inch down, uses 1·49 barrels of cement ; whereas an aggregate varying from 1 inch to ¼ inch combined with the same sand, ¼ inch down, requires 1·67 barrels of cement for a cubic yard of concrete.

If the producer of aggregate materials can say what are the sizes of aggregates he can furnish they can be used to make a concrete of a given strength. Should concrete of a strength other than 3,000 pounds per square inch be desired, then another table would be calculated with the proportions and quantities required accordingly ; but the table given here is confined to the use of concrete for concrete roads where a better quality and greater strength are required than is necessary for concrete for many other structures.

Those who wish to study more fully the basis upon which this table is prepared should consult the bulletins of the Structural Materials Research Laboratory, Lewis Institute, Chicago, particularly Bulletin No. 1.

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Abrams' Table of Proportions and Quantities for One Cubic Yard of Concrete

Based upon laboratory investigations, using approved materials, compressive strength, 28 days, with workable plasticity, 6 by 12-inch cylinders, 3,000 pounds per square inch.

SIZES		FINE AGGREGATES, SCREEN OPENINGS PER INCH														
COARSE AGGREGATES Inches	Cement in Barrels Aggregates in Cubic Yards	0-28			0-14			0-8			0-4			0-⅜ In.		
		Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse
No. 4 Screen to ¾	Proportions	1	1.3	2.4	1	1.6	2.4	1	1.8	2.3	1	2.0	2.3	1	2.7	1.5
	Quantities	1.96	.37	.69	1.85	.44	.66	1.82	.48	.62	1.75	.52	.59	1.79	.72	.40
No. 4 Screen to 1	Proportions	1	1.3	2.7	1	1.6	2.6	1	1.8	2.6	1	2.0	2.5	1	2.6	1.8
	Quantities	1.90	.36	.76	1.77	.42	.68	1.72	.46	.66	1.67	.50	.62	1.72	.66	.46
No. 4 Screen to 1½	Proportions	1	1.2	3.1	1	1.6	3.2	1	1.7	3.1	1	2	3	1	2.4	2.4
	Quantities	1.82	.32	.84	1.68	.40	.79	1.63	.41	.75	1.61	.47	.72	1.62	.57	.57
No. 4 Screen to 2	Proportions	1	1.2	3.5	1	1.5	3.5	1	1.6	3.7	1	1.9	3.6	1	2.2	3.1
	Quantities	1.75	.31	.90	1.63	.36	.85	1.55	.36	.85	1.52	.43	.81	1.53	.50	.70
No. 4 Screen to 2½	Proportions	1	1.1	3.8	1	1.4	3.9	1	1.6	4.0	1	1.8	4.0	1	2.1	3.5
	Quantities	1.72	.28	.97	1.58	.33	.91	1.51	.35	.89	1.49	.40	.88	1.50	.46	.78
No. 4 Screen to 3	Proportions	1	1.1	3.9	1	1.4	4.1	1	1.5	4.1	1	1.7	4.1	1	2.0	3.7
	Quantities	1.69	.28	.97	1.58	.33	.97	1.49	.33	.90	1.49	.37	.90	1.49	.44	.81
⅜ to ¾	Proportions	1	1.3	2.3	1	1.7	2.3	1	1.9	2.3	1	2.2	2.2	1	2.8	1.4
	Quantities	1.96	.37	.67	1.85	.46	.63	1.82	.51	.62	1.75	.57	.57	1.79	.75	.37
⅜ to 1	Proportions	1	1.3	2.6	1	1.7	2.6	1	1.9	2.5	1	2.2	2.4	1	2.7	1.7
	Quantities	1.90	.36	.74	1.77	.44	.68	1.72	.48	.64	1.67	.54	.59	1.72	.68	.43
⅜ to 1½	Proportions	1	1.3	3.0	1	1.7	3.0	1	1.9	3.0	1	2.1	2.9	1	2.6	2.2
	Quantities	1.82	.35	.80	1.68	.43	.75	1.63	.46	.73	1.61	.50	.68	1.62	.63	.53
⅜ to 2	Proportions	1	1.3	3.3	1	1.7	3.4	1	1.8	3.5	1	2.0	3.4	1	2.4	2.9
	Quantities	1.75	.34	.86	1.63	.41	.83	1.55	.42	.80	1.52	.45	.77	1.53	.62	.66
⅜ to 2½	Proportions	1	1.3	3.7	1	1.6	3.7	1	1.7	3.9	1	2.0	3.8	1	2.3	3.3
	Quantities	1.72	.33	.95	1.58	.37	.87	1.51	.37	.87	1.49	.44	.84	1.50	.51	.74
⅜ to 3	Proportions	1	1.2	3.8	1	1.6	3.9	1	1.7	4.0	1	1.9	4.0	1	2.2	3.5
	Quantities	1.68	.30	.95	1.58	.37	.91	1.49	.37	.88	1.49	.42	.88	1.49	.48	.77
½ to ¾	Proportions	1	1.5	2.3	1	1.9	2.2	1	2.1	2.2	1	2.3	2.1	1	2.8	1.3
	Quantities	1.96	.44	.67	1.85	.52	.61	1.82	.56	.59	1.75	.59	.54	1.79	.75	.34
½ to 1	Proportions	1	1.5	2.5	1	1.9	2.5	1	2.1	2.4	1	2.3	2.4	1	2.8	1.6
	Quantities	1.90	.42	.70	1.77	.50	.66	1.72	.53	.61	1.67	.57	.59	1.72	.72	.41

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		Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse
½ to 1½	Proportions	1	1.4	2.8	1	1.9	2.9	1	2.1	2.9	1	2.2	2.8	1	2.7	2.1
	Quantities	1.82	.37	.75	1.68	.47	.73	1.63	.51	.69	1.61	.52	.66	1.62	.65	.51
½ to 2	Proportions	1	1.4	3.3	1	1.9	3.3	1	2.0	3.4	1	2.2	3.3	1	2.7	2.7
	Quantities	1.75	.36	.86	1.63	.46	.79	1.55	.46	.78	1.52	.50	.74	1.53	.62	.62
½ to 2½	Proportions	1	1.4	3.6	1	1.8	3.6	1	1.9	3.7	1	2.1	3.7	1	2.6	3.1
	Quantities	1.72	.35	.91	1.58	.43	.85	1.51	.42	.83	1.49	.46	.81	1.50	.57	.69
½ to 3	Proportions	1	1.3	3.7	1	1.8	3.8	1	1.8	3.9	1	2.1	4.0	1	2.4	3.3
	Quantities	1.68	.33	.92	1.58	.42	.89	1.49	.40	.86	1.49	.46	.88	1.49	.53	.63
¾ to 1	Proportions	1	1.7	2.4	1	2.1	2.4	1	2.4	2.1	1	2.6	2.2	1	3.1	1.5
	Quantities	1.90	.48	.68	1.77	.55	.63	1.72	.61	.53	1.67	.64	.55	1.72	.79	.39
¾ to 1½	Proportions	1	1.7	2.7	1	2.0	2.8	1	2.3	2.7	1	2.5	2.7	1	3.0	2.0
	Quantities	1.82	.46	.73	1.79	.50	.70	1.63	.55	.65	1.61	.59	.64	1.62	.73	.48
¾ to 2	Proportions	1	1.7	3.1	1	2.0	3.1	1	2.3	3.1	1	2.5	3.0	1	3.0	2.4
	Quantities	1.75	.44	.80	1.63	.48	.75	1.55	.53	.72	1.52	.56	.67	1.53	.68	.55
¾ to 2½	Proportions	1	1.7	3.3	1	2.0	3.5	1	2.3	3.4	1	2.4	3.4	1	2.9	2.8
	Quantities	1.72	.43	.84	1.63	.47	.83	1.51	.52	.76	1.49	.53	.75	1.50	.64	.62
¾ to 3	Proportions	1	1.7	3.5	1	2.0	3.7	1	2.3	3.7	1	2.4	3.6	1	2.8	3.1
	Quantities	1.68	.43	.88	1.58	.47	.87	1.49	.51	.81	1.49	.53	.79	1.49	.62	.68
1 to 1½	Proportions	1	1.7	2.8	1	2.0	2.9	1	2.3	2.7	1	2.6	2.6	1	3.1	2.0
	Quantities	1.82	.46	.75	1.68	.50	.73	1.63	.55	.65	1.61	.62	.62	1.62	.75	.48
1 to 2	Proportions	1	1.5	3.2	1	1.9	3.5	1	2.2	3.3	1	2.4	3.3	1	3.0	2.6
	Quantities	1.75	.39	.83	1.63	.46	.85	1.58	.51	.76	1.52	.54	.74	1.53	.68	.59
1 to 2½	Proportions	1	1.4	3.4	1	1.9	3.8	1	2.0	3.7	1	2.3	3.7	1	2.7	3.1
	Quantities	1.72	.35	.86	1.58	.45	.89	1.51	.44	.83	1.49	.51	.81	1.50	.59	.69
1 to 3	Proportions	1	1.3	3.6	1	1.8	4.0	1	2.0	3.9	1	2.2	3.9	1	2.7	3.3
	Quantities	1.67	.33	.90	1.58	.42	.94	1.49	.44	.86	1.49	.48	.86	1.49	.59	.73

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FROM THE AISNE TO YPRES, 1914.

FURTHER INCIDENTS IN THE STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG.-GENERAL G. WALKER, D.S.O.

(*Continued*).

Our time on this front was now drawing to a close, as the Indian Corps were arriving in France and one of its Divisions (Lahore) was to relieve us. The relief began on the right, the 15th Brigade I think being the first. There was a certain amount of trouble in the relief as the Germans apparently knew of it and took the opportunity to test the value of the Indian native troops. They did this to some purpose at one point, for they cleared out the 8th Gurkhas, after knocking out all their officers. I found a crowd of the little men in my farm, which was 5 miles from the scene of action, next morning. After enquiry, they told me that their Paltan (Battalion) was destroyed; they certainly seemed to have been dispersed. However, the rot was stopped by bringing in British troops and, after stabilization, the relief of the line proceeded. Our casualties during this period were 2 officers wounded, and 2 killed and 5 wounded amongst the men.

Our left (14th Brigade) came last and we were relieved on October 30th, my work being taken over by a Company of the 3rd (Bombay) Sappers and Miners. I can't remember the number of the unit but I know that it was what used to be the old 4th Company of that Corps, which I had myself commanded as a subaltern in 1896. Eighteen years before as a subaltern, I had been in precisely the same position in the Indian Sappers & Miners as I was at the moment in the British Service, *i.e.* the Commander of a Field Company. This Sapper & Miner Company was commanded by Captain Paris, R.E. They had a most unfortunate experience a few days after, in fact I think it was the day after they relieved us. They were ordered together with a Sikh Regiment to make a counter attack on Germans, who had entered Neuve Chapelle. For some reason they did this under the 3rd British Division. The attack was most gallantly executed and quite successful, but the Force lost all their British officers, either killed or wounded. The native troops held on as long as they could, but, as no support was forthcoming, they had eventually to retire and this they did under their native officers and in good order.

The G.S.O.3 of the 3rd Division told me that it was one of the

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most gallant feats that he had ever seen and regretted that circumstances should have been such as to necessitate the use of Engineers on such a service. I saw the Subadar of this Sapper & Miner Company in hospital at Boulogne some months after and he told me the story of his experiences. He ended up by saying that, when they could hold out no longer, the Company had retired " section by section," and that they could do no more. Poor old man, he was utterly broken down when I saw him, both in body and mind, and I remember him as a smart young Sikh to whom I had given his first stripe. I don't think any of the British officers of this unit escaped. Paris I know was a wounded prisoner, and Hayes-Sadler was killed. Our time on this front was now over and on October 31st we marched out of Le Touret at 12.30 p.m. We marched north via Merville to Vieux Berquin, where we spent the night of the 31st, and then on to Courte Croix farm near Flêtre and not far from Bailleul, where we came under the 13th Brigade. We were told we were to have a rest and on arrival at 10 a.m. started to settle down. However, our rest was short-lived as at 2 p.m. we were on the road again for Bailleul. On arrival at this place I got an order to put the men in motor buses and go to Ypres. I asked how the tools were to go and the Staff seemed astonished that there were such things. However in about an hour the order was cancelled and we passed through Bailleul and on to Dranoutre where the 15th Brigade under Count Gleichen were assembling. His Staff Captain found us our billet and there we settled in. The place was afterwards known as Engineer Farm and was occupied by us at intervals for a long time (1st November).

The 5th Division were now supposed to be in reserve. I have no memory of what the Infantry were doing. We were taken over by the C.R.E. and put to work on a second line that ran in front of Neuve Eglise and behind Wulverghem and thence South towards Nieppe. The line had been laid out I believe by the Engineer-in-Chief, anyhow I know that we were visited one day by his assistant. He was much surprised at the number of times I wanted to sit down that day—I wonder if he knew how tired I was !

Our workmen were civilians and very good work they did. We got a little shelling but very little and it was all day work, so we got good nights in bed. It was such a relief—it bucked up the men a lot as may be imagined. All this time the Cavalry were holding or trying to hold Messines in front of us and I have no clear recollection of what happened from day to day—except that the British eventually retired from Messines but not so far as the line on which we were working. However, we were not to be left very long at this work. On the 6th November about 6 p.m. we got orders to march next day to Ypres and to report to the 1st Corps. The 17th Company of the 5th Division were ordered also and we marched together.

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We had a starting point given to us on the Bailleul-Locre road for 11 a.m. (7th) and off we went. Such a tedious trek—a bad road crowded with the remains of the 7th Division coming back from Ypres. I met their Signal Company on the road and its O.C. gave me a most lurid description of the situation, which we were on our way to face. However, it was a fine day and the sun was shining, we were fit and well and the future might bring what it would for all we cared. We went through Locre, La Clytte, Dickebusch to Kruisstraat, where we halted to feed, while I went on to find the 1st Corps H.Q. It was located at Trois Tours Chateau near Brielen.

I saw a lot of French troops in Brielen village and they had heavy guns all over the place. I received orders to go to 3rd Divisional H.Q. at the White Chateau on the Menin Road, East of Ypres, an unsavoury spot if ever there was one. It was just where the Roulers tramway crossed the Menin road and has now I fancy disappeared. When I last saw it in May 1915 it was a ruin and uninhabited. I got back to Singer and the two Companies about 6 o'clock and we started off again for Ypres. No guide and none of us knew the way. Ypres was in flames, or the main street was at any rate, and undergoing quite a heavy bombardment, quite the usual thing as we had reason to know later. A kindly policeman, on hearing our destination, advised us to avoid the centre of the town and to take the road round the Southern ramparts, (the old Chemin des Rondes) until we got to the Menin Gate, where we were to turn to our right. We followed his advice. The old-time defences had been laid out as gardens and it was very hard to see which was the road. It was pitch dark under the trees and we had a miserable time finding our way. One of our troubles was that the pontoons, with their 6-horse teams, were too long for the turns in the roads. However, we got through all right and met the 56th Company R.E. at the Menin Gate en route to rejoin their Division (3rd), so we were all bound on the same errand. We all got to 3rd Divisional H.Q. about 10 p.m.—12 hours on the road. We were ordered to join the 9th Infantry Brigade (Brig.-General F. Shaw) and to get on with it at once. We were to billet in the stables of the Chateau. I left the Company under Johnston to have a meal and went on to see my Brigadier, telling Johnston to follow to Hooge or thereabouts when ready. I found General Shaw in a little hovel, which was his H.Q., on the Menin Road about a mile beyond Hooge, a little further back than Stirling Castle, but on the North side of the road. I found them all quite cheerful and very glad to see me. The Divisional Staff (Sir F. Maurice G.S.O.1) had given me to understand that we were in for a warm time on this bit of front, and he was a true prophet, but there were no signs of anxiety in that cottage. I served for 14 days with this Brigade and nothing could exceed the kindness of the Brigade Staff or their solicitude for the

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welfare of myself and my men. Many a night when I went in the Brigadier would say: "Lie down and have a sleep until I am ready," and put me on his own bed. We were often short of sleep in those days. We were engaged I soon discovered in a battle since known as the 1st Battle of Ypres. We were hanging on by our eye-lids, but no one seemed to be worried and everyone was cheerful. Such an asset that is to a soldier, to be able to laugh at any rotten thing that happens. A serious-minded man who never laughs and has an irresponsible conscience may make money, but he will never be a soldier, and I suppose that is the reason that no good soldier ever makes money.

I should say that the troops in the lines here were considerably mixed up. We (9th Brigade) held the ground astride the Menin Road including Herintage Chateau on the South side. (*Plan* III). The Brigade consisted of the Royal Fusiliers, Scots Fusiliers, Northumberland Fusiliers, and Lincolns. Which the Battalions were I can't remember. The Battalion Commanders were McMahon, (killed while we were there) Douglas-Smith, Yatman, and Smith, the last three survived and became General Officers. My work with them was only at night and I remember meeting Yatman long after when he said to me: "I know your voice but I don't remember ever having seen your face before." Similarly with Smith. My recollection of him was that he was a very tall man who always wore a very long uniform overcoat. Months after when I met him in daylight as a Brigadier in another Division I found that he was quite a small man. I suppose it was the long coat that misled me.

On the left of the 9th Brigade was the 1st Division and Fitzclarence's Brigade was their right formation; on the right was the 15th Brigade (Count Gleichen) of the 5th Division, beyond him the 8th Brigade (McCracken) and 4th Guards Brigade (Lord Cavan). Singer with the 17th Company R.E. was with Count Gleichen and was my R.E. next-door neighbour, on my right. Hooge was still a village and the Chateau was standing. The 1st Division H.Q. were in the village living in quite nice houses. The 2nd Division H.Q. were at Potizje. Between Hooge and our White Chateau the ground north of the Menin Road was covered with horse lines and Field Ambulances. However, these were soon moved back.

The Menin road was our main artery and was constantly shelled but seldom hit. I only had two people hit on it during a fortnight and we went up and down twice a day. Our transport at night with food and stores used to go up through Hooge and halt at the commencement of what is now known as Inverness Copse, where the ration carriers used to meet them. This fact emphasises the difference between the intensity of the shell fire in 1914 and that to which we were subjected in 1918.

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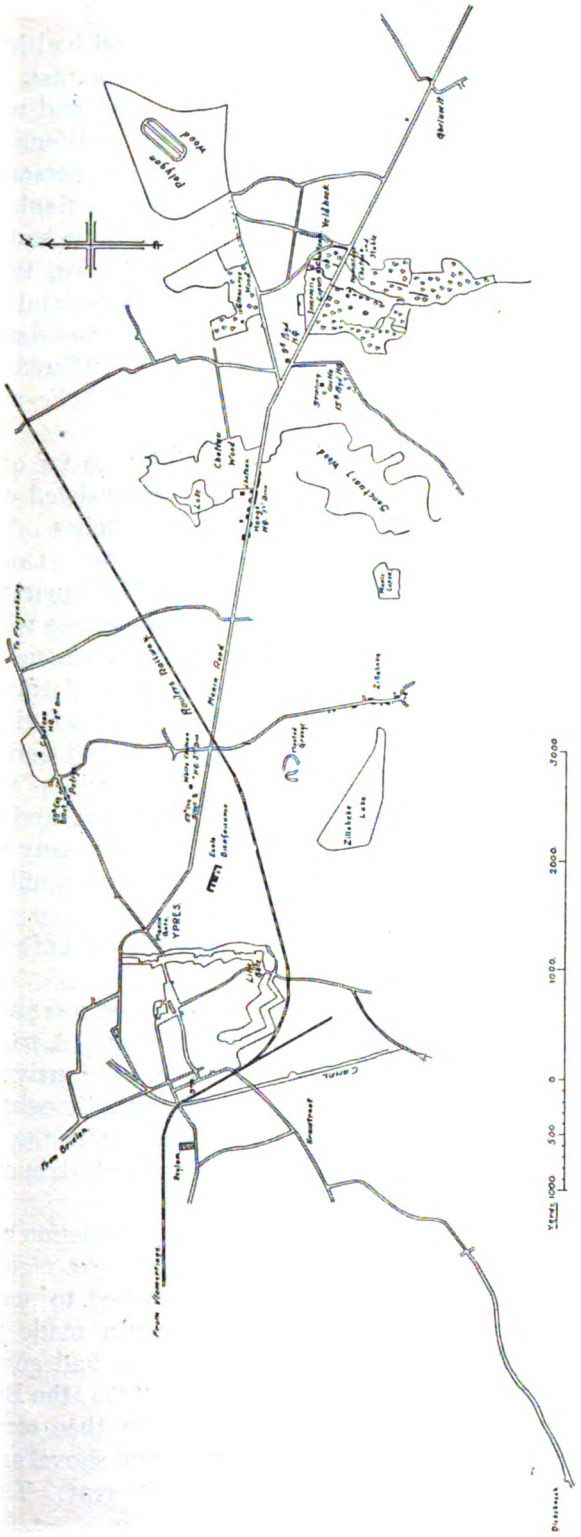

PLAN III.—*First Battle of Ypres, November, 1914.*

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I was going up to the trenches one evening and had just reached the border of Inverness Copse when I heard a man screaming. Thinking that someone had been badly wounded and was in need of help, my orderly and I made a search round and found a private soldier of a distinguished regiment sitting at the bottom of a wet ditch, singing lustily, but incoherently. He was flanked by two empty rum jars, the contents of which I imagine he had consumed as he was absolutely "blotto." He was, I believe, the happiest man in the Army at the time, as it was a horrid wet and cold night. So impressed was I with the comic aspect of the situation that I am afraid I left him in peace. Poor thing, he had suffered much and his lapse, except for the curtailment of the alcoholic refreshment of some of his fellows, had done little harm.

I fear that there has been but little mention so far of the R.E. work done at this time by the Company. It consisted of assisting the Infantry in wiring and completing their trenches. There were no materials for revetting and tools also were short. One night we got a present of 800 sandbags from Divisional Headquarters. They came up in state in a motor car, and goodness knows whence they had been obtained. I think it was the most handsome present I ever received. Our trenches were mostly 3′ × 3′ traversed fire trenches—they were not continuous but traced to give mutual support. The wiring was poor and scrappy also, and Germans often came through to snipe us in the woods. Our business was to put this right. There were no trimmings of any sort and the work entailed little but severe manual labour. The Company was on its legs daily from about 4.30 p.m. until 7 a.m., two 3-mile marches being done in that time as well as the work.

The following story will show how little was thought of entrenching work by some people :—

The left of the 9th Brigade was forced back one morning and the next night a new retrenching line had to be dug. A party of 200 Infantry was detailed for the job under me. On arrival I found that these people had no picks or shovels and thought I would supply. They had left their own 5 miles behind with the transport. I got some tools for them from a neighbouring Battalion and we set to work.

These men held the trenches that night on completion and in the morning were in their turn driven back. The next night another working party of the same Battalion was detailed to make a new retrenchment and the same demand was again made for tools. When I asked where the previous night's tools had gone to, the Battalion Commander said quite cheerfully: "Oh, the Bosche got those this morning when we fell back." Even then some people had not learnt that, in some situations, a pick and shovel are of more value than a rifle. The French were very different. The French

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infantry that I saw at this time went into the trenches with their arms slung and every man shouldering a shovel.

In spite of this casualness the Infantry were splendid. Nothing seemed to put them off. The Northumberlands had an advanced Company commanded by a man called Gordon. He was well in front of the general line and had poor support on each flank. He had splendid trenches deep and safe and was heartbroken when ordered to withdraw to conform with an adjustment of the lines, though both his flanks were entirely in the air by that time.

I spoke above of the scrappiness of the wire. Yatman, of the Northumberlands, and I were making a tour one night and were on our way to visit Gordon in his advanced post. We had to cross a bit of open heather land between him and the Lincolns on his right about 300 yards wide. The ground was covered by fire by day but there was no wire there so far.

On our way I heard a groan and on looking about we found a young German officer lying wounded in a hole. He had no belt but I can remember his neat boots and gaiters still. He was shot through the leg somewhere and affected to be in great pain. He would only talk German but seemed to understand English for, when I said we would leave the blighter until we came back, he at once cried: "Kamerade, Kamerade." We got back all right and brought him in and then we found a German rifle, with bayonet fixed, lying near him. He apparently had been in command of a sniping party and got laid out early in the adventure, for, when we got into the line again, we heard that there had been a great sniper hunt in our absence. The Lincolns bagged six—properly dead too, none wounded. Flint told me that he left his section to assist in one hunt. A fat German had got down into the bottom of a brambly ditch and was forcing his way along on his hands and knees trying to evade the attentions of a Lincoln man, who followed him along the edge, vociferating: "Come out you blighter, come out." The Englishman eventually got tired of the performance and jumped down into the bramble on top of the Bosche and finished him off with his bayonet and a rifle bullet. I don't know whether the Germans got anyone that night. I imagine not but there was a good deal of promiscuous shooting.

(*To be continued*).

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MEMOIRS.

MAJOR ARTHUR FFOLLIOT GARRETT, O.B.E.

BY the premature death, in most tragic circumstances, of Major Garrett, the Public Works Department of India loses a brilliant officer and the Central Provinces in particular sustain an irreparable loss.

The youngest son of Mr. W. Raymond Garrett, of Kilgaran, Co. Carlow, Major Garrett was born on 27th April, 1875, and was educated at Clifton College, whence he passed second into Woolwich; and the fact that he passed out of Woolwich first of his year and gained the Pollock Medal marked him out as an officer of outstanding merit.

Major Garrett decided on an Indian career, and on arrival in India was posted to the Military Works Service at Karachi, but was shortly afterwards transferred to the Railways Branch of the Public Works Department, where the early years of his service were spent at Sharigh on the Quetta line, and on the survey of the Kohat Bannu line, and later on Famine Relief Works in Rajputana in the great famine of 1899. A short period of 18 months as Assistant State Engineer of Jeypore State, under the late Colonel Sir Swinton Jacob, K.C.I.E., from whom he received his first training as an Irrigation Engineer, was followed by a further period of employment on railway surveys in the exceedingly trying climate of Sind, when a short course of study in a garrison class at Kasauli for promotion to his captaincy proved a welcome and much needed change.

It was about this time that Major Garrett formulated his theory of arched masonry dams, a form of construction that had previously met with little acceptance by engineers throughout the world, due perhaps to a lack of complete appreciation of the problems involved; Major Garrett was, however, no mere theorist, and as State Engineer of Alwar State, was the first to put his theory into practice in the construction of the Agar dam, thereby effecting a saving of 30 per cent. in the cost of construction. The theoretical considerations involved and a short account of the Agar dam were set forth in a paper contributed by him to the *Royal Engineers Journal* and published in the year 1908.

From Alwar Major Garrett was transferred to the Irrigation Branch of the Public Works Department and was posted to Raipur

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Major A. ff. Garrett, R.E.

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in the Central Provinces, and it was in this work that he found the best scope for his abilities. His investigations into the theory of flood storage in reservoirs, shortly after his taking up the new appointment, completely revolutionized the design of reservoir spill-ways in the Central Provinces, and have resulted in a vast saving of expense to Government. The results were embodied in a pamphlet and adopted by Government as a basis for all future designs. These investigations were hardly complete, however, before Major Garrett was at work on a set of hydraulic diagrams for the design of irrigation canals; these diagrams, which received the highest commendation from Sir John Benton, K.C.I.E., then Inspector-General of Irrigation, were based on Kutter's formula for the flow of water in rivers and channels, and made it possible to ascertain at once by simple inspection the best section of channel for any given conditions. They have since been largely adopted in every province throughout India and, it is believed, have proved of great utility in Mesopotamia; it is impossible to exaggerate the amount of time and labour saved by their use and this work alone will keep his memory green so long as water is harnessed for the use of man.

A further set of diagrams for the design of notched falls on canals and the publication of a comprehensive collection of formulæ and diagrams for use by all hydraulic engineers followed in quick succession, when his labours in this direction were interrupted by his recall to military duty on the outbreak of war in 1914.

First of all employed in training the 65th Field Company at the Curragh during the winter of 1914—15, he proceeded with them to Gallipoli, where he was wounded by a sniper's bullet, which passed through his neck, and after a short period of convalescence, was ordered to India in March, 1916, where he was specially selected as A.C.R.E., Karachi.

His life thereafter, until his return to the Irrigation Department at the end of 1919, was one of continual overwork and strain, first of all at Karachi and then at Rawal Pindi, with hardly a day's leave, which would have been trying enough to a man in the best of health; and, just as there appeared a chance of his getting back to the work and life he loved in the Central Provinces, in response to repeated and urgent requests from the Government of those Provinces, the Afghan war broke out and Major Garrett was appointed C.R.E. of the 2nd Division. The severe hot weather which followed in Peshawar completely undermined his health and despite a few weeks' rest in the hills preparatory to rejoining his post as Superintending Engineer in the Central Provinces, he fell an easy victim to influenza shortly after his return, and this illness appeared finally to destroy all his powers of resistance. Malaria in an acute form supervening, he was ordered home immediately, but passed over in his 45th year on March 28th, 1920, in a hospital at Marseilles,

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where he was buried with military honours in the new British military cemetery at Mazargnes. His wife, Ida, who survives him and whom he married in 1900, is the daughter of the late Rev. J. F'A. Gavin.

Space does not permit of more than a passing reference to the fact of his being a keen astronomer, who restored the old Observatory at Jeypore whilst Assistant State Engineer there, and of his having twice gained the Montgomerie Memorial prize.

He had a brilliant future before him, and was to have been Chief Engineer of his old Province in India on the retirement of the present incumbent.

By his death, the Central Provinces sustain a loss which it is impossible to measure, and the officers of the Irrigation Department lose a chief who was beloved by all who worked under him.

COLONEL K. A. JOPP, LATE R.E.

ON the 15th May, 1920, at Atheldane, Westgate-on-Sea, there passed away Colonel Keith Alexander Jopp, one of the very few surviving officers of the Royal Engineers who joined the Corps through the Honourable East India Company's College at Addiscombe.

Born at Ootacamund, in India, in the year 1838, he was the son of Colonel John Jopp and Eliza, daughter of Colonel Tom Morris. He was educated at Cheltenham College, where his name is still to be seen on the schoolroom wall among the list of distinguished scholars. Here he was successful in winning first prize in practically every subject, with the exception of the one in which he probably had most right to expect success, namely in painting. In this subject he had the misfortune to be pitted against no less an opponent than the late Mr. Breton Riviere, R.A., who pre-deceased him by only three weeks. From here he passed into the East India Company's College at Addiscombe, heading the list of candidates and retaining his position at the head throughout the whole of his two years at the college. On passing out he was awarded both the Sword of Honour and the Pollock Medal, as well as a large number of other prizes. He was gazetted Ensign in the Royal Engineers, and appointed to the Bombay Presidency, in September, 1857, being then only 19 years of age.

His war service included the Abyssinian and Afghan campaigns. In the former he was among the very first to set foot on African soil, being included in the advance reconnoitering party sent out in September, 1857, under the command of Colonel W. L. Merewether, C.B., R.E. During this campign much heavy work devolved on him, he was responsible for the clearing of the road to Magdala. In the final dispatches of this campaign which were written by Colonel

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Phayre, R.E., the name of Colonel (then Lieutenant) Jopp was accidentally omitted, but the omission was noticed by Lord Napier, who immediately wrote a special dispatch requesting that his name be included, as he had rendered very valuable services throughout the whole campaign.

The whole of Colonel's Jopp's service was spent in India, with the exception of a short period at Chatham. He married Mary Egerton Smith, daughter of the late Adam Freer Smith, and leaves a son and a daughter. He possessed a high sense of *esprit de corps* ; in his eyes the Royal Engineers could do no wrong, and any slight suggestion to the contrary made in his presence was sure to receive a severe rebuke.

Although he lived to the ripe old age of 82 years, he retained his strength and great vitality almost to the last. He passed away in his sleep, without any pain or suffering, mourned by his son and daughter and his grandchildren, to whom the latter years of his life had been devoted. He was carried to his last resting place in Birchington Cemetery, covered with the Union Jack which he had served so faithfully.

GENERAL G. W. WALKER, COLONEL COMMANDANT, ROYAL ENGINEERS.

GENERAL George Warren Walker was the sixth child of General George Warren Walker and his wife, Anna Marion Patton. His father commanded the Meerut Brigade during the first Afghan War, and his maternal grandfather was at one time Governor of St. Helena. He was descended from the Northallerton branch of the Walkers of Tilehurst. He was born on the 6th April, 1823, at Colombo, where his father was at that time Deputy Adjutant-General, and was educated at Addiscombe as a cadet of the East India Company's Service, from which college he gained a commission as 2nd Lieutenant in the Madras Engineers on the 9th December, 1842. On the 15th November, 1858, at Inverness, he married Margaret Jessie Anderson, by whom he had nine children, three of whom survive him. He was promoted Lieut.-Colonel on 30th September, 1866, and Major-General 6th March, 1868. He held the office of Chief Engineer and Secretary to Government of Madras in the Public Works Department from May, 1872, to 1st February, 1877. He left India in April, 1877, and was promoted Lieut.-General 15th April, 1878, General 28th November, 1885, and Colonel Commandant Royal Engineers 25th July, 1899. In July, 1905, he married his second wife, Mrs. Augusta Mary Turner (*née* Marshall), who died in January, 1918. Of his five grandchildren three served in the European War, and one, Gervase Mapletoft Warren, a Lieutenant in

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the 3rd Battalion Leicester Regiment, was killed in France in 1918. General Walker died on the 4th July, 1920, at 4, Forester Road, Bath, the residence of his daughter, Miss I. M. Walker, and was buried in Lansdown Cemetery, Bath. The funeral was of a private nature. Major and Brevet Lieut.-Colonel H. Trevelyan R.E., attended to represent the Royal Engineers, and a wreath was sent by the Assistant Adjutant-General, R.E., on behalf of the Corps.

CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

SIR,—I would like to take advantage of Major-General Thuillier's invitation to discuss the points dealt with by him in his lecture, which was reported by you in your issue of May, 1920.

Infantry, dismounted cavalry, and artillery should be trained to carry out all tactical engineer services not requiring the services of artizans or engineers, but including such services as require knowledge of "bush carpentering," such as ordinary revetments. All other engineer services should be performed by the engineers under the command of the C.R.E., either on the demand of Brigadiers or other Commanders, or initiated by the C.R.E. or his officers and approved by the Divisional or other Commander. The military engineer should be the specialist in defence work of every description, and Brigadiers and other Commanders should be in a position to call on the C.R.E. for the assistance of officers and other ranks when required. On the other hand, the C.R.E. should be in a position to call on Brigadiers and other Commanders for unskilled assistance in the execution of engineer services when necessary.

The C.R.E. should be a in a position to depute a Company Commander or other officer as his representative in any section of the defence. It is highly undesirable to place engineers permanently under the command of any person except the C.R.E. But this may be done for the purpose of special operations and moving warfare on the understanding that when the army comes to rest such engineers shall at once revert to the command of the C.R.E., or as may be decided by the Divisional Commander.

I am of opinion that a suitable proportion of engineers to a complete division is :—

(*a*) Three Field Companies (old style), together with pioneers attached or three double companies, including pioneers, as apparently is intended under the new proposals.

(*b*) One A.T. Company for back area and domestic work and for service to the artillery.

(*c*) One Pioneer Battalion, which, together with other Divisional Pioneer Battalions, can be brigaded under the C.E. for special service.

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The whole should be under the command of the C.R.E., who should have the necessary rank, especially in view of the possibility of the Commander of the Pioneer Battalion being a senior Lieut.-Colonel. Hence the C.R.E. should be a Colonel.

The C.R.E. should have staff consisting of an Adjutant, a Field Engineer (civil), and a Field Engineer (mechanical).

The above proportion is insisted on for the reason that engineers have always hitherto been overworked, and the third Field Company not in the line has rarely been given an opportunity to rest, refit, reform, and re-train. The C.R.E., owing to lack of staff, has always been overworked, and has been far too immersed in details to enable him to carry out the higher duties of his high position in a manner free from petty worries.

I regret that Major-General Thuillier places the onus of obtaining information and of establishing *liaison* with the Divisional Commander and Divisional Staff on the C.R.E., and on the C.R.E. alone. My views run on totally different lines. There is only one person in a Division on whom this onus should rest and that is the Divisional Commander. We have heard far too much about the whims of Divisional Commanders in their treatment of C.R.E.'s and Engineers, implying inefficiency of Divisional Commanders in their management of the Divisional Engineers. This attack is not directed against Major-General Thuillier.

As everyone who has any knowledge whatever of military engineering in the field knows, engineer services take far longer to mature than any other service carried out in the field. For this reason C.R.E.'s have to consider possibilities as regards future operations and decide on probabilities and discuss the same with the Divisional Commander with a view to a final decision as to carrying out such services, often before a definite decision as to operations is made, and thus, it is fully recognized, often taking a good many risks.

It is, in 90 per cent. of cases, not sufficient to wait until the General Staff issues its formal orders, even if such was possible it would be highly undesirable to let the enemy guess at probable movements by violent activity and by turning certain areas into hives of industry at the last possible moment, unless, of course, this is part of a scheme of deception.

The C.R.E. therefore, must be, in my opinion, as fully informed by, and as fully in the confidence of, the Divisional Commander as is the G.S.O.I., and should be fully informed of all secret and confidential matter as is the latter officer. I need hardly point out that it is exceedingly annoying to a C.R.E. to find that quite junior staff officers are often entrusted with secret matter which is not communicated to himself and which often profoundly affects his schemes, but is not recognized by the Divisional Commander and staff as doing so. It is extremely galling also to a C.R.E. to have to be continually asking for information from the Divisional Staff.

The Divisional Commander invariably sets the tone at a Divisional Headquarters. If he manages the C.R.E. properly and treats him properly, all will be well, provided always the C.R.E. is a white man and efficient. If the Divisional Commander does otherwise the staff will

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treat the C.R.E. as a foreman carpenter and all will go wrong unless the C.R.E. has sufficient strength to stand up to this treatment, and even he will go down in time.

Major-General Thuillier touches on the question of engineer intelligence. In my experience the Intelligence Staff have not been successful in producing engineer intelligence, chiefly owing to the fact that no military engineer exists on Intelligence Staffs, but also owing to want of knowledge on the part of those staffs as to what military engineers want to know and ignorance of who, from, and how, to elicit the necessary information.

In my opinion a military engineer with a suitable staff should study future campaigns together with the General Staffs at the War Office, and military engineers should be represented on the Intelligence Staffs down to that of the army, or of lower formations if the necessities of the campaign require it.

A striking feature of engineer intelligence is that the Intelligence Staff is so often prepared to accept engineer intelligence as true, provided the agent is trustworthy in other branches and irrespective of whether he is qualified to give opinions on engineer questions. Another remarkable point as regards intelligence is the inclination to accept information from the Air Force as regards such matters as roads as definite and final.

Engineer *liaison* with other arms is a most important point, but requires the appointment of more officers than at present. Engineer information during operations is often a most important and difficult service, especially when moving warfare has been definitely established for a time. The C.R.E. may make certain that information even on such an important point as water will not come through the wires in anything like a respectable time, as the wires will be always congested by General Staff priority messages. The only possible method of getting engineer intelligence back to C.R.E.'s is by motor-bicycle, but no provision is made for this in Establishments. The C.R.E. even has no car.

Yours, etc.,

R. P. T. HAWKSLEY, *Lieut.-Colonel, R.E.*

REVIEW.

DETERIORATION OF STRUCTURES IN SEA WATERS.

FIRST REPORT OF COMMITTEE OF INSTITUTION OF CIVIL ENGINEERS. (H.M. Stationery Office). Price 30/-.

In the summer of 1916 the Council of the Institution of Civil Engineers appointed a strong committee, including some of the leading Harbour Engineers, to investigate the question of the effect of sea water, in various localities, on structures of timber, metal and concrete. A grant in aid of the cost was promised by the Government. The Port Engineers at some 46 ports scattered all over the world, were appointed correspond-

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ing members of the committee and invited to furnish reports of the structures in their charge. These reports, together with much other valuable information, are included in the weighty volume now under review, which is liberally illustrated with plans of ports, diagrams of structures, and numerous photographs. The committee is carrying out various experiments in home and other waters, but as these will necessarily take some considerable time, the results will be published in a later volume.

The present book opens with a brief abstract of papers on the subject, collated from the proceedings of the Institution of Civil Engineers, dealing separately with timber, concrete, and iron and steel. Next is an article on the value of timber as a material for marine structures, with some botanical observations and notes. Following this is an extremely valuable paper by Dr. N. T. Calman, of the British Museum, on " Marine Boring Animals." The best known and most pestilent of these is the *Teredo* or " ship-worm." Its usual length is about 16 inches, but in tropical waters it sometimes reaches to four feet or even more. The *teredo* makes its way into timber through a small hole and then, by means of a shelly boring apparatus at its head, drills a tunnel, following the grain of the wood and, in a pile, usually in an upward direction. The bore hole is generally about half an inch in diameter and has a hard lining deposited in it. Being an expert miner the *teredo* works round knots, and never breaks into neighbouring burrows. The animal cannot live more than a few hours without access to salt water, and consequently is not found above the level of high water at neap tides. The only sign externally that it is at work is the minute entrance hole, and consequently a pile may be reduced to a mere shell without any indication of what is going on. The *teredo* is most prevalent in tropical waters, but is found in all seas. It cannot live in fresh water or where there is much sewage pollution, and it does not thrive in muddy water. The " gribble " (*Limnoria lignorum*) is quite a different animal, resembling a wood louse, but not more than $\frac{1}{6}$th of an inch in length. The mischief it does is altogether out of proportion to its size. The burrows are about $\frac{1}{20}$th of an inch in diameter and from $1\frac{1}{2}$ to 2 inches in depth, but, being oblique, seldom penetrate more than half an inch. In a very short time the *Limnoria* will eat into the whole surface of wood, between low water and half-tide levels, till it becomes a spongy mass. This is washed away by the waves and a fresh surface exposed to attack. In this case the ravages of the animal are quite obvious.

Other pests are the *Sphæroma*, allied to *Limnoria*, and the *Chelura Terebrans*, a wood-boring Crustacean.

Dr. J. Newton Friend contributes a chapter on " The Corrosion of Iron and Steel," in which he explains the difference between rusting and graphitization. Cast iron is especially liable to the latter form of deterioration when immersed in sea water : the metal is converted into ferrous oxide and retains its shape, but becomes so soft that it can be cut with a knife.

The action of water on iron is dependent on the amount of salinity and also on the temperature, with curious variations. Thus at 11°C. undiluted sea water is more corrosive than fresh. At 13°C. the two

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waters are equally corrosive. Whilst at higher temperatures sea water is less corrosive than fresh.

Dr. Newton Friend discusses the relative corrodibilities of wrought iron and steel, and comes to the conclusion that no general rule can at present be laid down. Much depends on the position of the metal and the kind of corroding medium. As regards cast iron further research is necessary.

A large number of reports from corresponding members of the committee are printed. These refer to nearly all the more important ports in home waters and in the Dependencies and Crown Colonies. They contain a mass of valuable information. Unfortunately, space does not admit of their being referred to in detail here. Mr. M. F. G. Wilson, a member of the Special Committee, contributes notes on the reports, and states the broad general conclusions to be derived from them as regards the following structures, viz., timber, reinforced concrete, ordinary concrete, iron and steel. In conclusion we have the "General Report of the Committee embodying the results of their investigations to date."

Timber.—No known timber will resist the attack of marine organisms. Greenheart is by far the best. Injections of creosote prolong the life of timber but do not provide immunity. The harder the timber the less creosote it will absorb and consequently the less protection is obtained. Charring is beneficial for a time. Piles are frequently cased in sheets of Muntz metal on felt, with satisfactory results. Nearly all reports, however, state that Muntz metal made in the last few years is of inferior durability. Wooden piles are sometimes cased with concrete. In tropical waters *teredo* and *limnoria* will eat through piles 12 inches square in a few months. As a protection against the latter, flat-headed "scupper" nails are sometimes driven into piles as closely together as possible. The rusting together of the heads makes a continuous covering.

Reinforced Concrete.—This material is now extensively used in substitution for timber in the construction of piers and jetties. It is not possible yet to estimate its life, but some valuable lessons have been learnt. It is essential that the reinforcement should be in its proper place so that no portion of it should have less than 1½ inches of concrete covering it, 2 inches is better. Cases are reported of failure due to stirrups being within ½ inch of the face of piles. The result is corrosion of the metal and splitting of the pile. The concrete should be made as impermeable as possible. Piles are sometimes coated with tar or other substances. Spots of rust appearing on the surface should at once be cut out, the metal cleaned of rust, and the concrete made good. A number of valuable specifications for the concrete are given in the reports. There is no doubt that wharves of this material, at any rate in tropical waters, will long outlive timber structures. One objection to them is that they are much more liable to injury from being bumped by vessels coming alongside. Timber fenders should always be provided. The jointing of diagonals and uprights requires to be done with great care otherwise damp will penetrate to the reinforcement.

Ordinary Concrete.—The reports on this material are, with few

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exceptions, satisfactory. Structures are either of mass concrete laid *in situ*, or of blocks made in a yard, and after being carefully seasoned, lowered into position by means of "Titans." It is of great importance that the face should be as impermeable as possible. All concrete is, of course, more or less porous. Some few years ago a report, not referred to in the work under review, was published on concrete structures in harbour works in the United States. It appeared from this that in many places, especially in warmer waters, the sea had an alarming effect resulting from its chemical action on cement. A report from Halifax, N.S., describes extensive damage to concrete-in-mass piles, caused by frost. At high water the surface is slightly penetrated by sea water, freezes and expands, thawing again with the rising tide. The face then falls off in powder. In seven years the damage was, in places, 15 inches in depth.

Iron and Steel.—Cast-iron piles, with wrought-iron super-structure, have been used for wharves, etc., for many years. In later years wrought iron was substituted for cast, and more recently mild steel has been used. There are cast-iron piles still standing which were driven more than 70 years ago. There is frequently more deterioration of metal structures above high water mark, due to atmospheric effects, than below. The reports describe in great detail various methods of protecting metal work either by tarring or the use of paints and other substances.

The volume is a mine of information for all engineers who have to do with the construction or maintenance of structures in sea water in any part of the globe. Before submarine mining companies were abolished, R.E. officers had charge of numerous piles and wharves. There must, however, be a good many apart from these. Every branch of the Corps Library should have a copy.

WM. PITT, *Colonel, late R.E.*

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 98.—*The Military Importance of Waterways.*—Major von Steffen states that the use of waterways to ease the load which military operations impose on railways, has now become essential. Behind the German lines on the Western front there were 2,300 kilometres of navigable waterways, but traffic was considerably influenced by the fact that there were no less than 465 locks, and that the largest vessel that could be used universally was one of no more than 280 tons. In 1916 the canal system was placed under railway administration and in June, 1918, it had at its disposal 464 tugs, 79 motor boats, 3,161 barges, 225 cranes, 12 dredgers, and 719 draught animals; 52 yards and depôts undertook the maintenance of this material. In addition to one construction and four operating companies, 9,747 inhabitants of the

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occupied territory were employed. After the offensives in the spring of 1918 the opening up of the Lys, the Somme and Aisne canals was undertaken with such energy that by July of that year no less than 190 kilometres of waterway had, in spite of considerable demolitions, been made navigable. From April to June, 1918, 12 million tons were carried, an average of 100 kilometres, and from September, 1917, to June, 1918, 400,000 men ; thus relieving the railways of the equivalent of nearly 1,000 fully loaded railway trucks. In spite of the limitations placed on the use of the canals by military conditions, the traffic on them was nearly double that of peace time. Finally, when they could no longer serve their proper purpose they became of considerable tactical use, and the inundations which they made possible afforded no little relief from pursuit during the German retreat.

Roll of Honour.—Infantry Regiment No. 395 (formed in September, 1916).—52 officers and many other ranks killed.

No. 99.—This number appeared on 27th March, instead of on the 17th. The delay is attributed to the Revolution and the general strike which followed it. The subscription is raised from 20 to 32 marks a year.

German East Africa in the World War.—The writer, an old East African, is naturally enough very proud of the wonderful success the Germans had with their native troops in that campaign. They were so devoted to their masters that even when the latter were interned at Tabora and Dar-es-Salaam they brought them food, news, and even money. When mobilization was ordered, far greater numbers presented themselves than could be embodied, and many time-expired Askaris came forward unasked ; there was never a thought of conscription. When von Lettow, after his 10 months' crusade in Portuguese territory, turned back into German East Africa, all the old Askari who had been wounded and left at their homes earlier in the war thronged to join him. The writer bitterly regrets the loss to the enemy of that beautiful colony to which he and so many others had devoted their life work. He hopes, however, that Germany will follow the example of Japan, who after the treaty of Shimonoseki, when Germany deprived her of the fruits of victory, held no meetings for the furthering of universal disarmament, made no burning protests in the name of justice or humanity, but kept silence, smiled, even served and at times went hungry, but always worked. Till at last the day of reckoning came in August, 1914, and she demanded interest and compound interest. So should Germany seek her revenge.

Atrocities.—The usual appeal for evidence regarding atrocities on the part of Germany's enemies continues to appear, and a notice regarding arrangements for defence of those for trial at Leipzig is given. Plenty of publications alleging cruelties committed by the Allied troops also appear.

The Channel Tunnel from a Military Standpoint.—General von der Boeck considers that the opposition to the project, which has always come from military quarters in England, is no longer so well grounded as before the war. He points out that the tunnel could never be seized by a *coup-de-main*—at any rate by Germany—and that even if the continental end was to fall into hostile hands, no use could be made of

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it till a sea borne force had seized the English end, together with sufficient ground for elbow room; a condition which presupposes the destruction of the British fleet. On the whole he considers the advantages of the tunnel to England far outweigh its disadvantages.

No. 100.—The leading article discusses at length the causes and consequences of the March "Putsch." The writer blames both sides, the Reds because they had planned a Red Terror and very nearly succeeded, and the Junkers because they had not planned enough and failed miserably. The unfortunate Government, lying between the two extremes, catches it worst of all.

Anxiety is expressed regarding the punishment to be meted out to the Junkers, and the fate of Russia, and the Kerensky Government is held up as an awful example of what happens if passions are once loosed against the "officer class." The writer hopes that the amnesty granted to the Reds will also be extended to the Junkers, and emphasizes the value of the latter's services to the Government in the November, 1918, Revolution and subsequently.

In discussing the attitude of the Entente, France heads the "hate" list, England and Belgium following at some distance. Churchill's speech, "The danger to Europe, which lay once in Germany's strength, now lies in her weakness" is heartily approved, at least the last part is, and the usual remedy of a stronger army advocated, with Bolshevism as the alternative.

Peace between Poland and Russia appears far distant, but the writer does not venture again to prophesy regarding the future of the campaign, and confines himself to a further plea for a stronger German army to meet any unforeseen contingencies from that quarter.

President Wilson's League of Nations is laughed at and a separate peace with America hoped for.

Officer Prisoners of War.—The publishers of the *M.W.B.* state they are in a position to offer a few linen night shirts to officer prisoners of war, who on return from captivity find themselves without means of support!

France's Armed Forces.—Some figures dealing with these receive the comment that they do not show many signs of disarmament. The Soviet armies are estimated from an extract from the Russian Press to consist of 16 corps and 8 cavalry divisions, in all 400,000 bayonets, 20,000 sabres, 15,000 machine-guns and 3,500 guns; behind these there is a reserve of a million more men. Yet another demand for a larger German army follows.

Honours.—The Bavarian Government is distributing a number of honours gained before the Armistice; Prussia still withholds them because they were abolished after the Revolution. The *M.W.B.* thinks this very unjust.

Official Notices.—Von Reinhardt says that cases have come to the notice of the Ministry of Defence in which German officers attached to foreign commissions of control have met with obstruction and even disrespect from other German officials with whom they have to deal. It must be remembered that the task which these officers have under-

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taken is a very distasteful one and must not be made more so by the action of those officers and officials with whom they come in contact.

No. 101.—The output of military books continues to increase ; whether in this case supply creates demand or *vice versa*, it is difficult to say, but every number of the *M.W.B.* contains reviews, usually eulogistic, of fresh works by German military authors. Possibly the enforced idleness imposed by the terms of the Treaty on so many officers and the dissolution of the Great General Staff have something to say to it, together with the fact that the publishers of the *M.W.B.* are also great publishers of military works in general. Lieut.-General von Schwarte has collected the views of 19 different authorities, each expert in his own line, and merged them into a book entitled " The Military Lessons of the Great War." General Freytag-Loringhoven compresses the subject " The Higher Command " into a space of 17 pages, and says that every effort must be made to prevent the next war becoming one of positions, in which only the lower arts of leadership can be exercised. He also declares that a war of manœuvre necessitates more decentralization of command than one of positions. Artillery, engineers, cavalry, machine-guns, aeroplanes, etc., all receive consideration, but as the whole is compressed into one moderate-sized volume, each can only be treated in the roughest outline.

Germany, the Entente and Bolshevism.—When will the danger of Bolshevism be appreciated ? It must either be destroyed or allowed to spread its imperialist ideas all over Europe and Asia. France is declared to be mad, but the other Allied Powers are beginning to appreciate the situation. They must, however, understand that the use of all weapons is called for and not merely of economic ones. The article is of course another plea for a larger army to be left to Germany.

The Trial of War Criminals.—All who are on the list, and their representatives, are urgently invited to address themselves to the Leipzig Defence Association which has very important information for them. It is also notified that the working up of all their cases is in the hands of the state-attorneys who are pledged to secrecy and cannot be called as witnesses.

The Prussian Cadet Corps ceased to exist on 10th March. Major-General von Reinhardt issues a farewell order and looks forward to better days to come.

Roll of Honour.—Reserve Infantry Regiment No. 66.—100 officers and many other ranks killed. A young pioneer subaltern, who survived seven severe wounds during the war is noted as having been killed by a German's bullet during the recent disturbances.

No. 102.—Ex-Governor Dr. Seitz, contributes a long article on the dismissal of Bismarck based on the hitherto unpublished documents dealing with this event.

Roll of Honour.—The Reichswehr publishes its first rather pathetic roll of honour—11 officers killed during the March disturbances in the industrial districts.

No. 103.—*The Military-Political Situation in the World.*—The article deals chiefly with the internal state of affairs in Germany. The Govern-

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ment is blamed for weakness and tenderness towards the Reds and for insults to the only really sound members of the community, the officer class. The French General Nollet, chief of the inter-allied commission of control in Berlin, is charged with seeing bogies and inducing France to act as she did in the Ruhr district. The wish is expressed that he should give place to a nice quiet general who would make no trouble. Differences of opinion among the Allies are noted, but it is thought doubtful whether Germany will be able to derive any advantage from them. The Reds fought very poorly against the Government troops, but nevertheless managed to inflict appreciable losses, particularly in officers. The auxiliary forces, such as the "Zeit-frei-williger" and "Einwohner wehr" though in one or two cases they were not a success, on the whole did useful work in preserving order and protecting lives and property. This is in itself quite enough reason for those who wish to render Germany powerless to demand their abolition, and strangely enough even in Germany itself there are plenty of enthusiastic pacifists who make the same demand and would even wish to include the Reichswehr. Thus enemies within and without are working for the destruction of all power of resistance to the disintegrating influences of the age and this with the storm cloud of Bolshevism rising blacker and more threatening every day. Will the Government show any backbone or will it surrender all power to the small Bolshevist minority which seeks to establish a tyranny of blood and terror?

The Officer in Present Days.—The late Minister of Defence, Herr Noske, wrote in the *Vorwarts* a strong defence of the officers, stating that they were loyal, in many cases to the death, during the Kapp affair and deserve the thanks and not the curses of their countrymen. In spite of this, however, the feeling against them is steadily rising, and the editor of the *M.W.B.*, in hope of preventing what will, if continued, drive the officers into the arms of the extreme Reds, publishes an article of which the following is a précis:—"Whether an officer is monarchist or republican does not affect the following considerations. Recently every decent officer has been obliged to ask himself if he can any longer stop in the army. After the revolution of November, 1918, the officers remained at their posts and brought the Army back across the Rhine in safety. Part of them were then discharged and part retained. The ruling thought among the latter was that they must stay on to save a general collapse, and they were right. The next thing was that they were abused all round, the Government doing nothing to protect them, until presently there came the danger from the Poles and from the Spartacists. Then a different tune was called. The officer was quite good enough to go and be killed, and by his sacrifices he saved the Government and the country. Those who had made all the trouble were not, however, prosecuted with any effectiveness and were soon at their pestilential work again, while the Government, by constantly giving way, managed to retain a deceptive state of calm. This caused many officers to ask themselves what was the use of risking their lives to win victories for a Government that did not know how to use them, but when quieter times came they all put in steady work for the reconstitution of such

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forces as the country still possessed. As these latter days have shown, their work again saved the Government from expulsion, and the country from disaster; Chancellor Ebert has shown his gratitude by stirring up the people against their saviours and, in order to curry favour with the Reds, attributed the Kapp 'putsch' to the 'officer caste' which had in fact very little to do with it. It was really civilians in conjunction with a few short-sighted officers and was hopeless from the outset. However, the Government set a general strike going, and when Kapp collapsed, thanked the working-classes for what had really been accomplished by the officers. The late Chancellor actually expressed his gratitude to the scum who had fought against the Reichswehr for their loyalty to the Government, and the rioters went scot free. All indications point to a resumption of the activities of the Reds, and officers must demand that their position be safeguarded and that they shall not be sacrificed on all occasions. They still serve, not for their meagre pay, but for love of country, and if they throw in their hands the Government will be obliged to have recourse to a corps of officers serving for profit. When that happens the country will soon understand that the old officers were the back-bone of the army. If the real officers spirit is destroyed, the army is also destroyed and the destruction of the State will quickly follow." Things have indeed changed since the days of Zabern.

The Significance of the Adhesion of Scandinavia to the League of Nations.—This it is stated, will considerably modify the politico-military situation in the North as regards Germany. During the war the neutrality of the three northern states prevented England from landing troops in Jutland or establishing a naval base in South Norway. Had she been able to adopt any such measures, Germany would have been obliged to maintain considerable forces to counteract them. No doubt England thought that the drawbacks consequent on a breach of neutrality would outweigh any advantages to be attained. Now, however, that is all changed, and it is a measure of the weakness of Germany. The intention of the Entente to surround Germany has been accomplished and in future Scandinavia must be prepared not only to extend favourable neutrality towards Germany's enemies, but even to take part in active operations by land and sea. Of Norway and Denmark nothing else was to be expected, as they had already sold themselves to England, with Sweden, however, it was different, and nothing but an intense propaganda has succeeded in turning her towards the League of Nations. She will see her mistake when the bill for the increased armaments, she will now be forced to maintain, comes in. The writer cannot be congratulated on the delicate handling of his subject.

Allied Missions.—Noske issues an Army Order regarding behaviour towards Allied Missions of Control. Apparently some difficulties have been placed in their way and he says that such conduct which only serves to prolong the supervision by the Allies, must stop at once.

Roll of Honour.—Alsatian Pioneer Battalion No. 15.—32 officers and 1,113 other ranks killed or missing.

L. CHENEVIX-TRENCH, *Major, R.E.*

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REVUE MILITAIRE GÉNÉRALE.

February, 1920.

THE TRANSFORMATION OF THE GERMAN ARMY, NOVEMBER 1918 TO NOVEMBER, 1919.

Under the pressure of circumstances the external aspect of the German Army has changed, but its spirit remains the same, as has been announced by General von Leckt, since his appointment as Chief of the General Staff. The Imperial Army is re-incarnated as the Reichswehr, and the three successive steps are :—

(i.) The demobilization of the Imperial Army,
(ii.) The creation of the Reichswehr,
(iii.) The organization of camouflaged reserves,

which will be treated separately.

The steps to be taken for the demobilization of the Imperial Army were studied at the end of 1916, based on the victory of the Central Empires and of progressive military disbandment, combined with economic reconstruction. Release was to be given in the following order :—

(i.) The oldest classes, commencing with fathers of large families.
(ii.) Pivotal men.
(iii.) Men who had guaranteed sources of livelihood.
(iv.) Men whose places had been reserved.
(v.) Men with no assured means of existence, who should be temporarily retained with the colours, and released as work could be found for them.

The defeat of the Central Powers rendered this plan nugatory, the German revolution broke out amongst a disillusioned people disgusted with war, and immediately on receipt of news of the Armistice all units not bound by the strict discipline of the battle-front dissolved to their homes. The provisional Government clearly saw that it must accept as a fact what it could not prevent, and, attempting to regularize the movement, promised demobilization in the shortest possible time, enjoined calm and patience, and all military and civil authorities, soldiers' councils, and people' commissaries preached order as a fundamental condition of rapid demobilization. The Government renounced the original scheme and adopted the simple plan of demobilization by classes.

The demobilization of the home army was at first far from methodical, and various instructions, some contradictory, were issued by several authorities, but all contained two points in common, an appeal for calm and patience, and the acceptance of the fact that the offenders, though in fact deserters, were on leave, and were to be disbanded wherever they were with as few formalities as possible. In the middle of November, 1918, the Minister for War published general instructions stating that it was impossible to disband the whole army, that the oldest classes up to 1899 inclusive would be released first, but that specially employed men could only be discharged when relieved.

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Alsace Lorrainians, and inhabitants of the Rhenish Provinces, except the 1818 and 1819 classes, were to be released immediately if they so desired. Every man who had quitted his unit, no matter for what motive, should apply to the nearest military authority, either for regular leave, in which case he would be informed of the formalities to be observed, and ultimately of the date of his discharge, or for a transport order to rejoin his unit. Those who complied would receive a bonus of 50 marks and a complete civil suit, and few failed to avail themselves of the concession. Those who rejoined, and those of the 1916 to 1919 classes were specially pressed to do so, were to be absorbed in the nearest depôt, since to send them back to their units would involve transport as for mobilization. All men necessary for the economic life of the nation, if not belonging to the immediately demobilizable classes (1890 to 1906), nor to those to be retained with the colours (1916 to 1919 classes) were also to be released as soon as possible. However, these regulations could not be applied blindly. Many of the demobilizables had no means of subsistence and would have to join the unemployed, and many specially employed could not be spared. The former were allowed to remain with the colours, and the latter were to be retained until they could be relieved by men of the younger classes. Failing sufficient of the latter being available, volunteers were to be called for from those already demobilized, and this system rapidly extended. The troops of the field army, after a short period of effervescence, retained their discipline. The Government, at first inclined to release them, ended by sending them back to their depôts in order to reduce unemployment, and units belonging to the occupied areas were allotted fresh regions. Units were allowed to demobilize direct (1) professional classes, (2) Alsatians, Lorrainians and inhabitants of the occupied territories. Units considered necessary as frontier guards were retained, being brought up to establishment from the non-demobilizable men of the rest of the army. Besides his bonus, route, and suit of clothes, each man was given rations for three days, and in case of need the Mayor of his Commune, provided his papers were in order, could give him a ration card for another week. He was entitled to free lodging when he could not join his home in the day, or at large centres for a short period if he was seeking employment. Measures were also taken to provide employment as soon as possible, and workmen's unions succeeded, when the Government had failed, in inducing employers to take back their old hands. The measures taken for the relief of the unemployed, however, resulted in a direct encouragement of idleness. The order for general demobilization was dated 10th January, 1919. The Provisional Government was forced by public opinion to abandon its first intention of retaining with the colours the 1916 to 1919 classes, but deferred the demobilization of the 1918 and 1919 classes until the volunteer and Reichswehr formations were well developed. Under the pretext of guarding against danger from Bolsheviks and Poles, six *corps d'armée* on the East frontier were considered as still mobilized and authorized to retain parts of the 1917 and 1918 and all the 1919 classes, but the strength still proving insufficient, in spite of volunteer formations, these six corps proceeded to recall the classes already demobilized. Also all

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units of the old army could retain provisionally all who wished to remain with the colours, re-engaging them for short periods of 15 days to three months, if they had no means of subsistence, or wished to transfer to the Reichswehr. The latter category produced so many men that strict selection was possible and all political suspects could be eliminated. As a result the army, which by 1st April, 1919, should have been reduced to cadres of long service soldiers only, presented no very skeleton-like appearance, and actually on that date consisted of about 300,000 men. The demobilization of the cadres proceeded with systematic deliberation. The demobilization machinery, consisting of the Army Corps staff, four subordinate (divisional or brigade) staffs, and battalion demobilization centres, found it necessary continually to augment their numbers, and eventually dispersing units came to equal in strength the units demobilized. Staffs of fortresses in the occupied areas were suppressed, also some of the army and fortress inspectorates, but schools for officers, N.C.O.'s and cadets, directorates and the higher inspectorates were retained, all that could be being transformed into civil offices, the remainder being incorporated in the Reichswehr. The demobilization centres were nominally retained to deal with repatriated prisoners of war, but instead of keeping the latter only for the short time necessary to complete administrative formalities, delayed their departures for two or three months on the pretext of re-establishing their health, which had been undermined by harsh treatment in enemy countries. The defeat and revolution, the fall of the monarchy and flight of the Emperor inflicted a serious blow to the feelings of the officers. At first many resigned, but the crisis past, enrolled in powerful leagues (Deutscher Offizierband, National Verband Deutscher Offiziere) and supported secretly by the Provisional Government the officers regained faith in themselves and their country, and the creation of volunteer corps and the Reichswehr opened a field for their activities. Although the acceptation of the treaty of peace left a large number of officers unemployed, on 11th November, 1919, nothing had been done to deal with their cases. Measures had, for diplomatic reasons in order to prove to the Entente the good faith of the German Government, been proposed, but came to nothing. So far was the Government from wishing to reduce the strength of officers that they have commissioned university candidates and N.C.O.'s.

To sum up. On 11th November, 1919, the old Imperial Army had ostensibly been dissolved. In fact it still existed, and there remained with the colours all the 1919 class, the specially employed, those re-engaged for short periods, and an increasing number of repatriated prisoners of war. Again certain units had been exempted from demobilization. The above gives a total of 150,000 to 180,000 men. The training cadres are intact, their distribution is as before the war, and all the large army directorates, schools and inspectorates, still function.—(*To be continued*).

A. R. REYNOLDS.

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CURIOSA MATHEMATICA.

Write the following numbers by the use of no numeral other than 2 (not even 0). Any letter or recognized mathematical symbol may be used :—

69 (using five twos only).
91 (using six twos only)
93 ,, ,,
133 ,, ,,
137 ,, ,,
147 ,, ,,
149 ,, ,,
483 ,, ,,

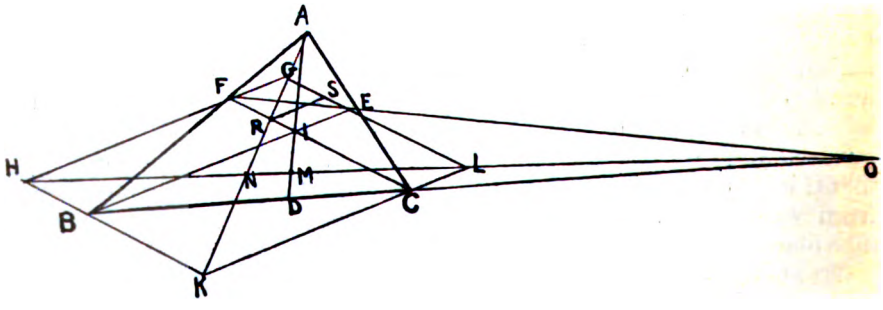
without making use of the number 222 in two ways

C. R. SATTERTHWAITE, *Major, R.E.*

PROBLEMS.

PROBLEM 9 (Solution by Lieut.-Colonel J. M. Wade).

A triangle ABC is such that the lengths of the bisectors BE, CF of the angles ABC and ACB are equal. Prove that AB = AC.



ABC is a △ such that BE, CF bisect the angles B and C and BE = CF prove AB = AC.

Through B, F, E, C, draw the parallels HBK, HFG, GEL, LCK to BE and CF. Join AK, HL. Produce HL to meet BC in O. Join AO. Draw RS parallel to BE.

Then the following can be proved :—

(i) FE passes through O.
(ii) KRG passes through A.
} By use of Menelaus' Theorem.

(iii) HKLG is a rhombus.
(iv) KG, HL bisect one another perpendicularly.

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(v) AD, AO are harmonic conjugates with respect to AB, AC, because BCEF is a quadrangle.

(vi) DAO is a right angle (follows from v and because I is the incentre).

(vii) FRSG is a rhombus.

(viii) FI and FR are both in the same direction, being both inside △ ABC and rhombus GHKL.

If AB is not equal to AC, suppose AB the greater, then it follows that

(*a*) BI > CI, since ∠ ICB > ∠ IBC.

(*b*) CF − CI > BE − BI.

(*c*) FI > IE > RS > FR, since FRSG is a rhombus.

(*d*) AMO is exterior and opposite to angle ANM of the △ ANM.

(*e*) Angle AMO is less than a right angle (follows from vi).

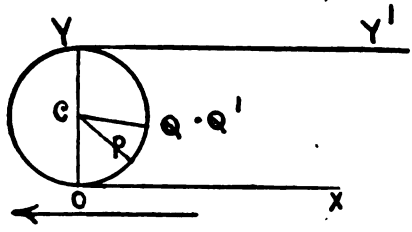
(*f*) Angle AMO < ANM, the latter being a right angle by iv, and this is impossible.

Hence, as the hypothesis AB > AC leads to an absurdity, it is wrong. Similarly AC is not greater than AB. Therefore AB must be equal to AC.

A correct analytical solution received from 2nd Lieut. W. E. C. Pettman.

PROBLEM 10 (SOLUTION).

A corkscrew is held with its axis perpendicular to a horizontal table, under what circumstances is the shadow of the screw thrown by the sun on the table a cycloid?



Direction of sun.

OPQY is the plan of screw on the table. This plan is circular and of radius (*a*). The screw is supposed to start from P, and to rise uniformly counterclock through a height (*h*) in an angle 2π, the angle $PCO = \alpha$.

The axis of x, OX, is so chosen that the plane of xz passes through the sun which is at infinity.

The axis if (z) is vertically upwards through O, and the axis of Y is OY ⊥^{r} to OX.

The sun's rays make an angle β with the table. Q is a point on screw and $\angle OCQ = \theta \angle \pi$.

Then co-ords. of Q are $x = a \sin\theta$, $y = a(1 - \cos\theta)$, $z = \frac{h}{2\pi}(\theta - \alpha)$.

If the ray through Q meet the table in Q^1.

Then the co-ords. of Q^1 are $x = a \sin\theta + \frac{h}{2\pi}(\theta - \alpha)\cos\beta$, $y = a(1 - \cos\theta)$.

These equations represent in general a trochoid, and cannot represent a cycloid unless $\frac{h}{2\pi}\cot\beta = a$.

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If this relation exist, and if the screw is placed so that $a = O$, the above equations become $x = a\theta + \sin\theta$, $y = a(1 - \cos\theta)$, which are the co-ords. of O if the circle OQY roll on YY^1 parallel to OX through an angle θ.

Note.—This problem works out quite easily provided the axis of x is suitably chosen.

Correct solutions have been received from Lieut. R. H. Nisbet and Major G. E. Painter.

PROBLEM 11.

The following interesting problem has been sent me by a brother officer:—

Given a triangle ABC and a point O, it is required to draw through O a line bisecting ABC.

PROBLEM 12.

Find the remainder of 47^{7385} when divided by 17.

J. M. WADE, *Lt.-Col.*

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SOME NATIONAL ASPECTS OF TRANSPORT.

By the RT. HONBLE. LORD MONTAGU OF BEAULIEU, C.S.I., ETC.

(With the kind permission of the Executive Committee of the British Science Guild).

AT the Annual Meeting of the British Science Guild on the 8th June, the Rt. Hon. Lord Montagu of Beaulieu, C.S.I., delivered the following address :—

Sir Isaac Newton once remarked that he felt like a child picking up pebbles on the shore of the great ocean of undiscovered truth. On this occasion I will not claim to be doing more than to be trying to pick up a few grains of sand. So distinguished an audience as this knows how specialized is the study of any great branch of modern science to-day, but I will try to avoid being too technical and lengthy in my remarks.

Automatic movement of any kind indicates life, and the science of movement in its relation to modern transport needs study as careful as the study made for generations past of movement in regard to celestial bodies, air, water, and animals. At the present moment, also, it must not be forgotten that political and social problems are many of them, closely bound up with transport in one or other of its forms. It is also interesting to reflect how analogous is the parallel between the human body and the body politic with regard to transport. Just as weak heart action, stagnation or undue pressure of blood, obstruction or weakness in the walls of the arteries or veins cause trouble in the human body, so *mutatis mutandis* defective systems of transport affect the nation's well being. Good transport facilities as in the human body mean a prosperous national life, while congested or impaired circulation directly or indirectly causes discomfort and disease. Moreover, it is now universally recognized that the civilization and development of a country can be judged almost more accurately from the excellence or otherwise of its transport than by any other test. Well did Rudyard Kipling say in his wonderfully prophetic story *With the Night Mail*, "Transportation is civilization."

I make, therefore, no apology for the subject of my address to you to-day. Indeed, the unprecedented and unsatisfactory state of nearly all our great transport agencies would have justified in any case the selection of this subject as one of special importance. It is a curious fact that for some time past, all over the world, there has been, generally speaking, hardly a single branch of transportation

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by land, sea or air, which is paying a commercial return on the capital invested. The railways of this country, for instance, are being subsidized by the State to the extent of about £30,000,000 a year, and our tramway systems, both municipal and private, are almost all in financial difficulties. There is hardly a branch of transportation by land, sea or air which is paying commercially, and the biggest system of all in this country, the L.G.O. Company, of London, is now incurring an actual loss in the working of its services. In the country, as opposed to urban districts, however, the outlook is not quite so gloomy, and some transport companies, especially those who convey heavy goods, are paying their way, with, however, a gradually diminishing margin of profit. Shipping, until lately, has been the most paying branch of industry, but all the great authorities, including Lord Inchcape, now prophesy that difficult times lie ahead, and that owing to the great increase in cost of construction, coal and wages, the profits which have been earned during the last three or four years are not likely to recur. In regard to the air, it is estimated that the present wonderfully regular services between this country and the continent are being carried on at a loss, and ordinary civil aviation is so expensive as to render it difficult for private individuals to indulge in it. We are, therefore, face to face with the fact that if these various kinds of transport services are to continue, either the users of them will have to pay more, or the State, that is either the taxpayer, or the ratepayer, or both, will have to continue subsidies to transport undertakings.

Under these conditions it is natural that there is no building of new railways in this country, and that the making of new roads is not being readily undertaken. But at the same time the congestion on road and rail alike is becoming intensified every month, and so-called transport "facilities," every morning and evening in the larger towns, have resolved themselves into a daily struggle by thousands for a seat in a railway carriage, a tram, or a 'bus. The journey to work and the return home is often almost as exhausting to workers with brain and muscle as the daily work itself.

The solution of most of the problems of modern transport, apart from any political aspects of the case, is not easy. There is the outstanding fact, however, that somebody, either the public or the State, must pay more and pay at once, for the transport services that are being rendered, otherwise collapse is imminent. If the travelling public is to pay, then a considerable increase must take place in fares and freight charges without delay. Such an increase will undoubtedly have serious consequences in regard to trade and to individuals who have chosen their residences or based their commercial or family calculations on the original lower fares whether by road or rail. On the other hand, we can hardly look to the State for permanent help, for the State is already much too heavily bur-

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dened, and at the moment cannot borrow at less than 6 per cent. High taxation, and fear of ultimate partial confiscation whether justified or not, has already led to a serious diminution in enterprise, and a decrease in the desire to save, and capital, therefore, for new transport enterprises, will be increasingly difficult and expensive to obtain. The investor, or in other words the person who habitually saves, is either hoarding or leaving his money on deposit at a low rate of interest. The ratepayer also, whether in town or country, is more highly rated than ever before, and rates in some localities, such as in the Potteries district, Hanley, for instance, have reached nearly 20s. in the £1. It is, therefore, difficult to see how more money can be obtained from the ratepayer and the taxpayer who, generally speaking, belong to one and the same class of citizen. It was recently suggested by Sir Henry Thornton, the General Manager of the Great Eastern Railway, that the State should help railways to borrow new capital for improvements. If this principle were adopted, would not tramways, public service by road, and roadways have the same claim as conveyers of the public? The larger non-railway transport companies, equally with railways, carry out services of the greatest value to the community, and if transport facilities are to be subsidized then all concerns carrying out such work must be treated impartially and alike.

On the other side of the balance sheet some economies are possible, and it may be said that the proposed abolition of competition, such as the combination of several railway systems, and the adoption of more scientific methods of handling traffic will save expense. The total amount of the saving, however, will probably be small and counterbalanced largely by the departmental expenses of the Government department set up to carry out control of transport. During the war, when railways were controlled, and very inexpensively and efficiently controlled as a national system, by the Railway Executive Committee, the savings were negligible compared with the rise in expenses, although there was no competition. Even now there is little real competition, most of the arrangements in regard to duplicate trains to the same locality still being in force. Moreover, the railway services in this country are neither so fast, frequent, nor convenient as those of 1914. I am of opinion, therefore, that it is not sound financially to rely on any saving sufficient to balance to any substantial degree existing or future deficits, whether those savings are derived from absence of competition or increased concentration or efficiency.

The recent statement issued by the representatives of the railway companies shows that not only has the cost of materials, coals, etc., increased by over 100 per cent. since 1913, but the wages are now well over £100,000,000 more than the pre-war amount. On the other hand the railway revenue has increased by £100,000,000, which just

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meets the increase in pay. If railway men in general are entitled to the recent rises, and without entering into any controversy I am of opinion that a considerable proportion of the rise in the past has been justified and was necessary, owing to the rise in the cost of living, there is no hope of economy or cutting down expenses here. The wages bill indeed has not ceased to rise, but is still rising. More revenue to meet more expenditure is therefore the only sound policy, and more revenue means higher charges for passengers and freight. But will the revenue respond to the higher charges? I am doubtful, for we see everywhere the tendency more and more pronounced for traffic to leave the railway for the sea, the canal, and the road. This tendency to leave the railway has been noticeable for some time, and if it increases, the outlook for the railway is not a cheerful one, for increased charges will not bring in a proportionate or satisfactory increase of revenue. Again, investments in transport concerns contrast unfavourably with investments in nearly every other direction, and the same conditions also apply to tramway systems and to some extent to urban mechanical road vehicle services. It is difficult to see how under these conditions any new money can be raised except at an exorbitant rate or by postponing hitherto prior obligations.

There can hardly be any doubt that the comparative cheapness of short-distance road borne traffic compared with similar rail borne traffic has already deprived the railways of much revenue. But before long roads made in the ordinary way will not be able to bear the increased continuous heavy mechanical transport. The time has now arrived, therefore, when we should consider whether special roads for mechanical road traffic from which all other traffic should be excluded, should not be provided, both from the point of view of alleviating the unfair burden borne by the present roads, which, except in respect of about half the main road mileage, are unfitted to bear this traffic and because only at very great expense can they be made suitable for carrying heavy mechanical traffic. The cheapness and superiority of transport on railways over roads has hitherto been due to the use of a steel wheel on a steel rail. The tractive force required to move a ton under such ideal conditions is only a pull of 15lbs. per ton. On an ordinary good tar macadam road on the other hand the force needed is about 40 to 45lbs., or three times as much, and as much as 100lbs. is needed in the case of a bad road covered with mud or dust. But there is no reason, as that distinguished engineer, Sir Frederic Bramwell, said many years ago, why a road should not be constructed of a material which had practically the same absence of friction as a rail. If so, road transport should require about the same power as rail transport. In regard to this, just before railways began to be made, what were called plateways were much in vogue in the North. These were tracks about 2ft. wide

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for wheels only, made of steel plates over which the steel tyres of carts conveying coal or other minerals passed, the resistance being of course, hardly more than exists in the case of the steel wheel on steel rail. It would be quite feasible to lay down such a plateway between London and Birmingham, for instance, perhaps partly in metal and partly in concrete or in some other durable material which would reduce the tractive force per ton on the road to say about 20lbs. per ton. The cost of a double track would, so far as I can estimate, be approximately that of a single line of railway, as it would be possible to use gradients up to 1 in 30, and hardly any buildings would be needed *en route*. The cost of operation also would be on a much smaller scale than on a railway, as there would be a very small permanent staff, no signals or stations, and few large bridges or viaducts. From the point of view of the producer and consumer, goods could be delivered from door to door without any intermediate handling, which is now a very expensive item in railway transport. If we extend this idea to big towns, to London for instance, it is conceivable that overhead roadways might be made from the suburbs for the exclusive use of fast-running road mechanical vehicles which would descend by means of lifts or connecting roads to the level of the streets at certain points. There might be alighting places and passenger lifts provided at the crossing of other streets, much in the same way as the overhead railway system in New York. A much higher average rate of speed could then be maintained by the road vehicles than those at present running in crowded streets also carrying slow horse traffic. I see no reason why overhead road traffic should not exceed the speeds of the ordinary suburban train services. I have always been convinced of the possibility and desirability of roads specially built and reserved for mechanical vehicles, and I am of opinion that to-day it is probably the best immediate solution of our increasing suburban traffic difficulties, and possibly of many other transport problems concerned with greater distances.

In a brief paper such as this it is impossible to discuss every national aspect of transport. But there is one suggestion as to how increased transport facilities should be assisted on which a word might be said. In the case of the extension by private or public capital of tramways, railways, or roadways, either outside large towns or into the areas which certainly benefit from better transport facilities, it may be asked whether the increased local values due to such construction should not contribute to the cost. To take a concrete instance, when the tube railway was extended to Golder's Green, a rise of between 300 and 400 per cent. took place in local values within the next two or three years. Towards this increase in land and house values the investor in the railway largely contributed, but the owners of the local property reaped the advantage

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without risking or paying anything themselves. No one will accuse me of being prejudiced in favour of the undue rating of property or the undue taxation of land, and hardly anyone is now an advocate of the kind of land taxes brought in under the famous and now defunct Budget of 1909. But it is quite conceivable that what might be called a local transport benefit tax, might be levied on those who become richer by the extension of traffic facilities in their areas. The method of assessment and manner of collecting such a tax requires a great deal of consideration, and I am not prepared to go into details to-day. But there can be no doubt as to the inherent justice of asking that property of any kind, benefited by the employment of public or private money, should pay something for the benefit conferred. The revenue thus raised could be used in at least three directions: (1) To cheapen the rate at which the capital could be raised to carry out these services; (2) To diminish the amount of capital employed, for instance, by the land required for the line being secured free or at a low rate; or (3) to enable passengers' fares and goods rates to be fixed on a cheaper basis owing to the annual or other kind of contribution made by the surrounding property.

By the Road Board Act, the Board had power to take a strip of land 220 yards at each side of a new road in order to recoup itself for a part of the cost by the betterment and the increased value of the marginal areas. I would suggest to the Government that something on the same principle might be applied in the case of new railways, tramways, and roads. On the other hand, it should be remembered that in many rural districts the advent of a tramway or railway, and even in some cases of a main road, by no means increases values; and may even depreciate local property.

Comparative sparseness of population and privacy are increasingly regarded as of value in many country districts. Propinquity to transport facilities does not always mean a rise in values. To take an example, house property near Clapham Junction, Willesden, or any other large railway centre is of comparatively little value owing to the disadvantages resulting from the noise of traffic and the unattractiveness of the surroundings. A transport benefit tax would therefore need much consideration.

In regard to the problems of transport and the science of movement, I suggest that a rich man, if there are going to be any such people left in the future, would do well to endow a Chair of Transport at Oxford or Cambridge or one of the newer Universities, in order that the science of transport might be studied apart from the unscientific and disturbing influences of politics and the clamour of trade disputes. The national importance of studying transport problems may be gathered from the fact that dear transport makes distance a greater disadvantage, and if we are to spread our population—and the wisdom of doing so is obvious—we must have cheap transport to enable the

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workers with brain and muscle to go between their homes and their work. Land and house values, salaries and wages, in most cases comfort or discomfort as well, depend to a large extent upon transport, and no housing scheme, however ably conceived and well financed, can succeed if the essential element of easy and cheap transport is lacking. I could say much on possible railway and tramway reforms in connection with this, but I have not time to deal at length with this subject this afternoon, but must reserve it perhaps for some further occasion. Nor am I able to touch upon such matters as the great increase in the sea speed of ships or the use of the air as a means of conveying goods and passengers. In regard to the latter point, I may say that I consider the airship to be the most promising vehicle for long distance services, while airplanes will probably be best for short services. I can also do no more than just mention the probability of use in future of gas suction plant for propelling locomotives, motor lorries, and ships, or refer to benzol and alcohol as being necessary and suitable for service in the internal combustion engine.

I have only been able to discuss briefly to-day a few of the problems which the student of the science of movement has to consider. Attempts to solve some of these problems are now being made by various public bodies without much practical experience, and in many cases without much scientific knowledge or research. The National Physical Laboratory has done splendid work in various directions including roads, but in regard to transport of all kinds, I am of opinion that the subject is so large and important that a special establishment is needed to carry out continuous research. It is remarkable that at present there is not a single Ministry concerned with transport to which a scientific staff in the true sense is attached, or a special branch in which these problems may be considered apart from the disturbing effects of politics or personal predilections and prejudices. The two Institutes of Civil Engineers and Mechanical Engineers are at present the only bodies which have really technical and scientific knowledge on many of these points. They are sometimes consulted now, but they might more often be consulted, by the Government. Among their members there are some whose opinions and services would be of great value. Government departments, however, have for many years past been somewhat contemptuous of science, and the Treasury has always been niggardly in its attitude towards invention and research. Moreover, I am sorry to say that I see little indication at present of any alteration in the Government's view towards science. Up to the beginning of the war all the great improvements in transportation were carried out by private enterprise at its own risk. Whether we take the case of James Watt and George Stevenson in regard to steam, Telford and Macadam in regard to roads, Charles Parsons in turbines, and Wilbur and Orville Wright in aviation, opposition and not

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encouragement was their lot. And so it will probably be to the end of time.

It is, I conceive, the business of the British Science Guild to endeavour to place its services at the disposal of the nation and the governing authorities, whoever they may be. And if the British Science Guild can assist in imbuing the political leaders of great masses of our fellow-countrymen with a regard for science, it will have performed services which though they will be at the moment hardly recognised at their true value, will be of lasting benefit to the nation.

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THE CHIEF CITIES, PALACES, AND FORTRESSES OF ANCIENT ASSYRIA.

Communicated by the COMMANDANT, *1st K.G.O. Sappers and Miners.*

ASHUR—(Qalat Sharqat)—was founded about 2000 B.C., and is first mentioned in the Bible in Genesis, chap. X.

It remained the political and religious capital of Assyria until the reign of Shalmaneser I. (c. 1300 B.C.). This king, deeming that a capital, where all the treasures of the Assyrian Empire were stored, situated on the right bank of the Tigris was too exposed to attack from Babylonia, moved across the Tigris and north of the Greater Zab, where he founded Calah (Nimrud).

Ashur, however, continued throughout to remain the religious capital and home of the patron deity of Assyria, and the excavated steles of Ashur range from the earliest times down to the days of Ashur-Bani-Pal (668–626 B.C.) ; that is to say, within twenty years of the fall of the Assyrian Empire.

At Ashur, the walls, quays, and fortifications of the ancient city have been most carefully and methodically excavated and traced on all sides. Already in the earliest days (c. 2000 B.C.) the rulers determined on fortifying the stronghold, and even after Shalmaneser I. transferred the political capital to Calah, Ashur's defences were strengthened and improved, until they culminated in a series of solidly built turret crested walls, pierced by eight battlemented gates.

Palaces abound, dating from all ages. But the ruins have been so methodically excavated that it is not easy now to follow their trace. The huge stage tower (ziggurat) attached to the oldest temple in Ashur, known as E-Kharsag-Gal-Kurra, " great mountain house of all lands," and sacred to Ashur the chief deity, has been uncovered and the temple itself traced back to Ushpia, a ruler who combined both priestly and royal functions.

A portion of the residential quarter of the city has been unearthed by the German expedition. Entire rows of private houses have been dug out ; they were of simple brick construction, one-storied, and with rooms grouped round a courtyard open to the sky.

A notable discovery was the large series of steles of various commemorative inscriptions of rulers, their consorts, and high officials. No less than twenty-five rulers and three " ladies of the palace " are known to us by these steles. These include the famous Semiramis, who turns out to be the " palace lady " of Shamshi-Adad IV., who ruled from about 823 to 811 B.C.

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It is evident that these monuments were erected by the rulers themselves and set up in various places of honour, and reveal in ancient Assyria, the custom of erecting monuments in public places.

The date of the destruction of Ashur is not definitely known, as is that of Nineveh, but it is outside the "Assyrian Triangle," and probably fell before the first onslaught of Cyaxares the Mede in c. 630 B.C.

CALAH or KALAKH (Nimrud)—was founded by Shalmaneser I. (c. 1300 B.C.), on the left bank of the Tigris, and north of the confluence of the greater Zab. In those days it was no light matter to move the capital from a site dedicated to the deified founder of Ashur. Shalmaneser ran the risk of offending, not merely his subjects, but the god who directed the destinies of the State. He insisted on the change from political and strategical motives, though he compromised on priestly questions by leaving Ashur the religious capital, and by beautifying its temples. Having secured his own capital on the left bank of the Tigris, he waged incessant and aggressive wars to maintain the Assyrian Empire.

Calah contains the remains of at least five palaces, namely :—

(*a*) North-west Palace, built by Ashur-Nazir-Pal (c. 883–859 B.C.).
(*b*) Central Palace, built by Shalmaneser II. (c. 859–824 B.C.).
(*c*) Central Palace, restored and enlarged by Tiglath-Pileser IV. (c. 745–727 B.C.).
(*d*) North-west Palace, re-built and enlarged by Sargon II. (c. 721–706 B.C.).
(*e*) South-west Palace, built by Esarhaddon (c. 681–668 B.C.).

In addition to these palaces, Sir Henry Layard discovered the remains of buildings and tombs in the south-east corner of the palace mound, and a vaulted chamber to the north of these.

To the north of the north-west palace lies the site of the temple of the war god Ninib, with its tower.

The ruins have not been so thoroughly or systematically searched as those at Qalat Sharqat, but some valuable finds have been recorded, notably the "Black Obelisk" of Shalmaneser II. (c. 859–824 B.C.), and two statues dedicated to the god Nebo by Ramman-Nirari III., King of Assyria (c. 812–783 B.C.). The former of these, which contains an account of the Assyrian Kings' campaigns, is particularly interesting to us owing to the representation and description of Jehu, the son of Omri, paying tribute.

The Kings built their palaces in the south-west corner of the city, which was enclosed by walls measuring about 7,000 feet by 5,500 feet.

These palaces were adorned in the most elaborate manner. Their walls were covered with carved bas-reliefs representing hunting and battle scenes descriptive of salient events in the royal career, while their doors and gateways were guarded by sculptured beasts. Many

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of these have now been removed, the largest share, through the perseverance of British excavators, having been secured for the British Museum.

After the days of Shalmaneser I., Calah seems to have ceased to be a royal residence for a time, and the capital may have reverted for a period to Ashur, or the newer city of Nineveh. The latter city, however, did not definitely become the chief city of Assyria until it was rebuilt by Sennacherib (c. 706–681 B.C.).

NINEVEH—(Kouyunjik and Nabi Younis)—the best known of all Assyrian cities, owing to its connection with the Bible, was probably built during the reign of Ashur-Bel-Kala about 1100 B.C., that is, within a century of the days of King David. The goddess associated with its temple was Nina, the chaste and warlike consort of Ashur.

Entrenched behind the Tigris, Nineveh was secure from sudden attack, and the coolness of the night rendered the heat of the day more tolerable to Assyrian Kings, who, when not engaged in war, were accustomed to spend the summer here in preference to their more southern palaces.

Ashur-Nazir-Pal (c. 883–859 B.C.), after his victorious campaigns, decided that the city of Nineveh was not large enough to display the wealth of his conquests. It was here that he had marched rebel chiefs in ignominy through the streets and put them to torture and death before the eyes of the crowd. It was here that the skins of his captives, flayed alive, were hung round the city walls; but the palace was not large enough for the multitude of his captured women and slaves. He therefore removed to Calah, where he built his most famous palace.

Nineveh fell into decay until the days of Sennacherib (c. 706–681 B.C.), who undertook the restoration of the whole city, and laid out avenues, streets, canals, quays, gardens, and aqueducts. Twenty thousand captives from among the Kalda, the Arameans, the Mannai, Cilicia, Palestine, and Tyre were impressed. Precious woods were brought from Syria, and marble from the north.

His palace was magnificent, with its woodwork of fragrant cedar and cypress overlaid with gold and silver, alabaster and sculptured marble panellings, and brilliantly glazed tiles.

Twelve bronze lions, twelve winged alabaster bulls, and twenty-four limestone goddesses kept watch over the entrances; vines and gardens were laid out; parks and private hunting grounds were prepared for the royal chase, while eighteen aqueducts secured the water supply of the city. The artistic merits of the bas-reliefs executed by Sennacherib depicting the triumphs of his reign, can be seen to-day, in the examples removed from Kouyunjik by Layard and others, and now lodged in the British Museum.

Esarhaddon, (681–668 B.C.), the successor of Sennacherib, added to the improvements of the city of Nineveh, but his energies were more

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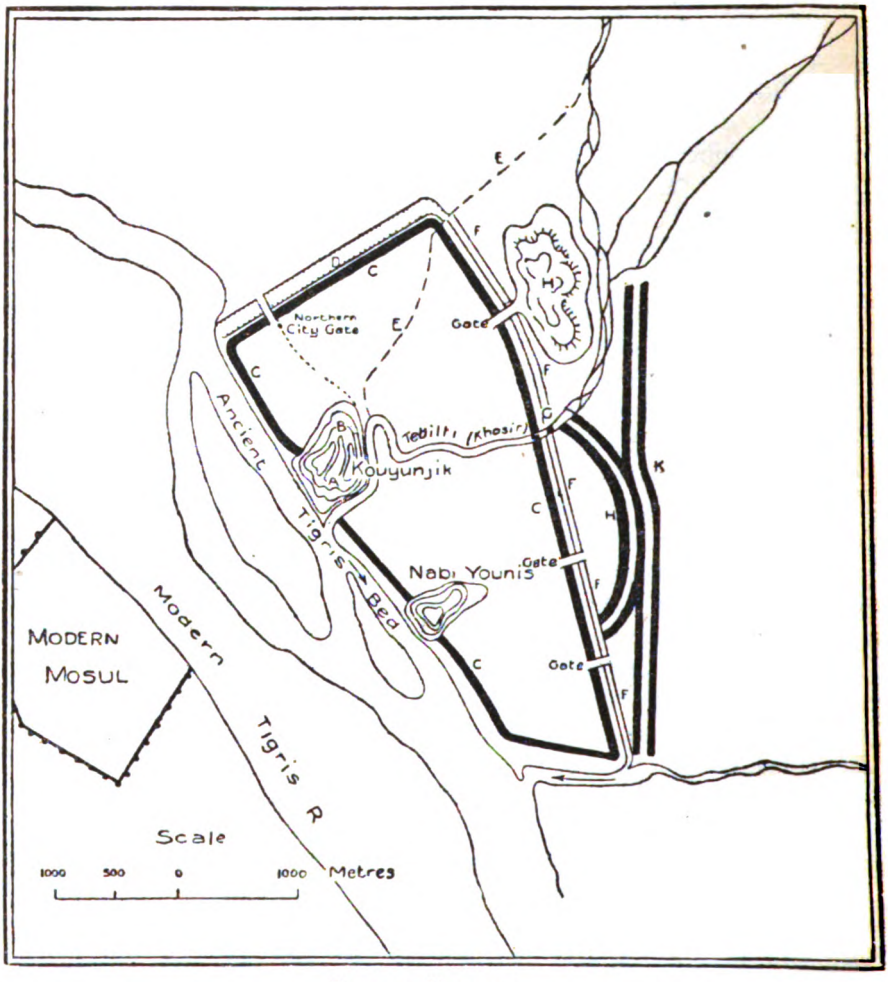
directed to the area now covered by the mound of Nabi-Younis, which has never been excavated.



PLAN OF NINEVEH.

Kouyunjik { A. Palace of Sennacherib c. 705–681 B.C.
B. Palace of Ashur-Bani-Pal c. 668–626 B.C.
C. Ancient City Wall Main Rampart.
D. Northern Fosse.
E. Ancient Canal.
F. Main Eastern Fosse.
G. Sluice Gates.
H. Demi-Lune Outworks.
K. Outer walled Fosse.

Ashur-Bani-Pal (668–626 B.C.), perhaps the greatest of the Assyrian kings, during his long reign of 42 years, built a new palace to the north of that of Sennacherib. The walls were even more splendidly covered with limestone bas-reliefs, generally representative of his campaigns.

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Greatest of all his works of peace, he founded and collected a library that has come down to us, and opened up for us the history of both Babylonia and Assyria. Ashur-Bani-Pal sent scribes to all parts of the ancient world and copied texts, historical, legendary, and divine, and stored them in the royal library. Altogether 30,000 inscribed tablets have been recovered up to the present, from this collection. Amongst these are historical texts and stories of the Creation and Deluge, myths and legends, incantation texts, medicinal prescriptions, astrological handbooks, birth omens, animal omens, divination of dreams; in fact, almost every branch of literature and science of the ancient world is represented.

Twenty years after the death of Ashur-Bani-Pal, Nineveh was captured by the allied forces of the Medes and Babylonians; but by an act of Providence, as the palaces crumbled into ruins, and the bricks became earth again, this same kind mother earth covered the treasures of Ashur-Bani-Pal and Sennacherib until the middle of the nineteenth century, A.D.

Externally, the ruins to-day do not appear very interesting. Sir Henry Layard and his successors took the precaution of filling in the passages through which they penetrated into the heart of the ancient palaces. Nevertheless, the mound of Kouyunjik to-day represents the accomplishment of the fate foretold by the ancient Jewish prophet Nahum; and the rescue of its history from oblivion 2,400 years after the fall of Nineveh is one of the triumphs of the nineteenth century.

THE LAST DAYS OF NINEVEH.—The fortified heart of Assyria was bounded by the Tigris on the south-west, the Greater Zab on the south-east, and the foothills to the north. The southern apex, near the confluence of the Greater Zab and Tigris, was protected by the ancient fortified city of Calah. Nineveh, the capital, was the chief fortress and main keep, the final stronghold of the Empire.

Before the last century of Assyrian existence, the Medes from the mountains had made their presence felt. Outlying fortresses to meet this danger were built to the north and east of Nineveh; of these, Dur-Sharrukin (Khorsabad), and Imgur-Bel (Balawat), have been identified, the former being built by Sargon II. about 710 B.C., while the latter already had a palace built by Shalmaneser II. (c. 859–824).

The problem before the invaders from the north-east was first to break through and neutralize this outer defensive line. Starting from Amadana (Hamadan) a Median king could choose either the road through the Karind Valley or a more northerly one passing through the modern Sulaimaniyah. Though the difficulties in the mountains were greater in this case, it allowed the possibility of the great feature of ancient tactics—surprise. Only two successful actions need be fought in Assyrian territory before the heart of

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Assyria was reached, one in the neighbourhood of the Altun Kupri fords and the other at Arbailu (Erbil), or the fords over the Greater Zab west of it, where in later years Alexander the Great defeated Darius and decided the fate of the Persian Empire. This accomplished, the formidable Nineveh had to be reckoned with, and the Medes might well be broken against its powerful defences.

Nineveh itself was surrounded by a wall in the form of an irregular quadrilateral, no two sides of which were parallel, and lay on the left bank of the Tigris (opposite the modern Mosul). The river flowed close under the walls on the south-west, and the two main palace areas (now the mounds of Kouyunjik and Nabi Younis) were so skilfully fortified that a single wall connecting the two was sufficient to ward off any attack on the river side. A portion of this wall, with its stone foundations, can be seen to-day, laid bare near the Khasir Bridge.

The south wall, about 870 yards in length, was rendered difficult for Median battering rams by a muddy stream, while the blunted northern wall, 2,150 yards long, was protected by a wide moat filled from a distributary canal of the Khasir.

The Eastern front had for a long time, and during the more aggressive period of Assyria, depended for its security on a single wall and moat. Sennacherib, deeming it insufficiently protected against surprise attack from the mountains, piled up obstacles and outworks so that it now presented a truly formidable appearance. It was skirted throughout its whole length by a main rampart, 5,400 yards long, and 50 feet high, which described a gentle curve from north to south. Outworks protected the gates through this wall and a deep fosse 50 yards outside the rampart was dug, some 20 feet deep and 150 feet wide.

Three large sluice gates built on a level with the rampart allowed the Khasir to be dammed back so that its waters could be diverted into the fosse and thus keep it full in case of siege. In front of each segment of the fosse was an outwork in the form of a demi-lune; yet further, as though this were not precaution enough, two walls, each over 4,300 yards long, were built in front of the outworks, the ditch enclosed between the walls being connected to and filled by the Khasir.

The normal population and garrison of Nineveh was perhaps 300,000, and within the ramparts the city was divided into minor walled sections of defence; (for population c.f., Jonah iv. 2, "more than six-score thousand innocents").

Cyaxares (Huvakshatara) the Mede, made a determined attack on Nineveh about 630 B.C. Undaunted by the natural strength of the Assyrian outworks he captured these and shut the remainder of the Assyrian field army within the walls of Nineveh.

The sluices were shut and the fosses filled. It is not known

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whether Cyaxares assaulted the city in his first attempt. Probably not, as his army consisted mainly of archers and javelin-throwers, while his siege train was probably insufficient. We do know, however, that battering rams were in use at this time among the Assyrians, and that Cyaxares had re-modelled his army after the Assyrian pattern. Before starvation could reduce Nineveh, however, Cyaxares had to raise the siege and hurry back to his own kingdom to repel an invasion of the Scythian hordes.

The final overthrow of Nineveh in 606 B.C., was brought about by the allied kingdoms of Babylon and Media, under Nabopolassar and Cyaxares. The western tributaries of Assyria alone, including Judah, remained faithful. Sin-Shar-Ishkun, King of Assyria, received no actual help, however, and was gradually driven in behind the walls and moats of Nineveh, where, the Assyrians remaining stout-hearted to the last, he held out as long as possible and beat off all assaults. Then with all food gone and with all munitions spent, and the inhabitants all round dying of starvation, Sin-Shar-Ishkun collected all his wives and children, all his gold and treasures in his palace, and, setting it on fire, perished with them in the flames. (c.f. The prophecy of Nahum on the doom of Nineveh, ch. III.)

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FROM THE AISNE TO YPRES, 1914.

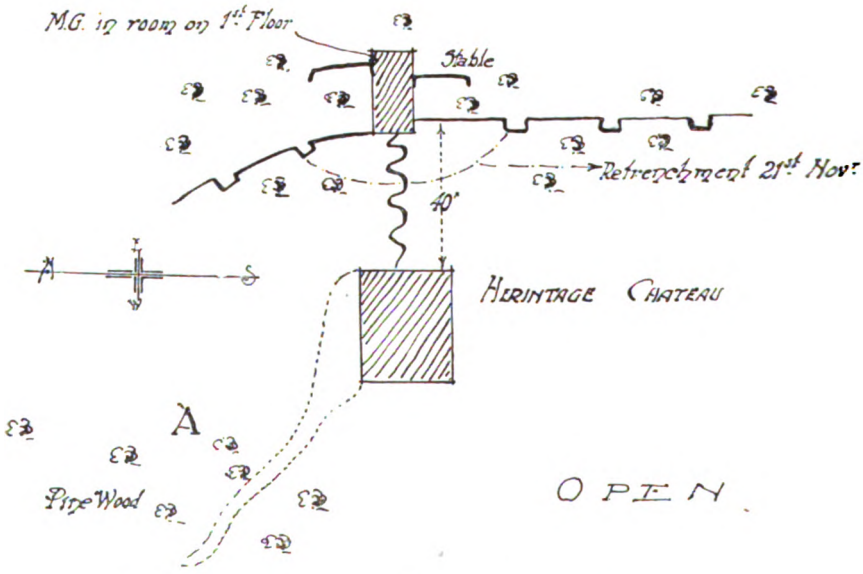
FURTHER INCIDENTS IN THE STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG.-GENERAL G. WALKER, D.S.O.

(*Continued*).

About the 11th November in beating off the German Guard attack we got pushed in a bit and our friend Gordon had to withdraw. We had a new line of trenches ready dug by this time about 300 yards in rear and just in front of Herintage Chateau. Just opposite the Chateau and actually in the trench line was the stable. It consisted of a couple of stalls and coach house on the ground floor and a groom's quarters and loft on top. Being of two storeys it dominated the trenches, and being hidden in the trees from view from the front it had not suffered much from shell fire. We and the Bosche both set a good deal of store by it.

In plan the situation was as shown below :—



The sketch shows the general idea of the defence.

We had much difficulty with the wing trenches as we had to sap them out from the building. One day the Bosche dropped a minenwerfer on the stable, cleared out our garrison and occupied it

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themselves. We had no bomb guns at this time so the Brigadier arranged that the place was to be retaken that night with the help of an 18 pounder gun. The gun was to be brought up to within 80 yards of the stable to 'A.' It was to fire four rounds into the building and then the Infantry were to go in with the bayonet. All was to be ready by 4 a.m. so that the show would be over by daylight. I was much amused at the amount of discussion that took place and I thought we should never get going. I know one C.O. of a Battalion told me that he thought it was impossible and sheer waste of life to try it. However, the Brigadier was determined and the gun arrived. It was a horrid, cold, wet night and the gun had to be man-handled into position, which was done successfully. I went to see the Gunner Officer when all was ready, and found him sitting on the trail of his gun watch in hand. It was very late and dawn was breaking. He told me he was waiting for the word and I went off to get it for him if I could. Just after I left him, however, he let loose his four rounds in quick succession and the Infantry charged. A good many people had been brought up in support and we were all standing about under the trees as the gun fired. Then ensued the most appalling hubbub. The Bosche went mad I think—he simply filled the upper air with bullets. The waiting multitude on our side disappeared like magic—I could hardly have believed there were so many holes about. The fusilade went on for about four or five minutes and then stopped suddenly and we all emerged from our holes laughing. I was in one with a Lance Corporal and I met Johnston, V.C., as I was coming out, emerging from another. The operation was a complete success. The R.E. withdrew, not having been called on to let loose their bombing party, which had been prepared with jampot bombs to help if required. Next night we went into the stable and it was a shocking sight—the floor was carpeted with dead Germans. I thought they were sacks at first until I turned a torch on. The shrapnel bullets must have been going round that coach house like racket balls in an infernal racket court.

A word should be said about bombs. At this period there were none officially. The service hand grenade was available but could not be issued, because the army was not engaged in "trench warfare." I think that was the term. I know I got a friend to steal 16 hand grenades for me one night. I had them fuzed and brought them up to a Cavalry Regiment that was in the line at the time. They asked me what the damned things were and, when told, implored me to put them in a dug-out, out of harm's way. They were *never used* and I returned them to my friend the thief.

Jampot bombs were much in favour with the "high command" and in fact anyone who had not got to touch them. Most R.E. Companies had a "factory" then. The manufacture was simple:

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Take a tin jam pot, fill it with shredded gun cotton and tenpenny nails mixed to taste, insert a No. 8 detonator with short length of Bickford's fuze, clay up the lid and you have a jam pot bomb. In action it was a difficult and dangerous weapon to work.

The procedure was to light the fuze with a match, if you had and could light one, and throw it for all you were worth. A pipe, cigarette or, for choice, a cigar, were the best lighters, as they were more certain and less conspicuous than a match. You needed a strong stomach and plenty of tobacco to be a successful operator by this method. I don't know that I ever knew anyone at this time who had actually thrown a jam pot. I do know, however, that we made some hundreds and gave them to the French when they relieved us. Later on a proper fuze lighter was introduced which eased matters considerably.

It is easy to speak lightly now of those days; it was not a light-hearted job to carry on at the time. We were at work for about 14 hours each night and had to prepare things during the day. I had to arrange at last that the half Companies went into the line night and night about as the men were knocking up and it was the only way to keep them going—the officers too needed rest. After coming in about 7 a.m., our first thing was a meal, then sleep. Most of them slept till 1 p.m. The senior out the night before, however, had to go to Divisional H.Q. to tell the night story, as our pitch in the line was a critical one. This individual got little rest that day. Then we had a meat tea at about 4 p.m. and on the road again at 5 or thereabout.

However, we were fit enough but dreadfully weary. During the first week of our stay at Ypres we billeted as stated before in the stables of the "White Chateau" on the Menin Road. We had to leave, however, on account of the shell fire. The first visitor arrived in the form of an 11 in. shell which dropped during the night in the middle of our horse lines. The horses were picketed all round the perimeter of the Chateau orchard and the shell fell plumb in the middle. The ground was soft so there were no casualties except that all the animals broke their bonds and fled—and all our windows were broken.

I was in the line that night and when I got back Johnston remarked on meeting me that he wished he had gone up to the trenches with me. He then showed me the hole to give point to his remarks. We started at once to dig shelter pits about the place and by after lunch had done a lot.

A day or two later I was riding down from Hooge and as I approached our house I saw the fire beginning again. The Germans started "laddering" a line running through an abandoned 60 pounder battery position on the Zillebeke Road and the Chateau, in hopes of finding the battery. I saw the drop of the shells approaching our

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house as I approached the level crossing. One fell just opposite the gate as I got to the crossing and upset and destroyed a G.S. wagon and team standing in the road. I galloped into the gate and gave up my horse and started getting the men underground. Two men were still in the billet and Johnston and I were standing at our door, when another shell came up and plumped down in front of us. We escaped untouched but both the men were hit. One, Sapper Chapman, was killed outright and the other had a splinter through his arm. They were within about 30 ft. of us and it was only a stroke of fate that saved us.

Chapman was a nice young fellow, a moulder by trade and a Belfast man by birth. He had done his colour service in the Company at the Curragh and joined as a reservist on mobilization. We buried him that night in the garden, after dark, just before we left for the line. I read the prayers of the burial service by the light of a lantern held by Sergeant Buckle, and Johnston prompted me as to how to shorten them as our time was limited. It was the only time I ever had to do this, so I suppose it impressed me. Johnston made a special point of my reading the commendatory prayer for a sick person, from the Order for the Visitation of the Sick. I had been to a good many funerals but did not remember ever having heard this prayer read before. It impressed me as being extraordinarily appropriate to the occasion, especially so as regards us who had survived: For our own condition was most truly "frail and uncertain."

The great struggle in the Ypres Salient was approaching a climax. The first crisis of October 30th had passed: the Germans were preparing for the second and last, which came on the 11th November. It is difficult to describe, except that everything was boiling up and the pressure daily became greater.

On the morning of the 11th I had been warned to be ready to act as Infantry but the day wore on and no orders came. At length, about 5 p.m., we were turned out. Three Companies of Sappers—17th (Singer), 56th (Nation), 59th (Self), I suppose we numbered 350 rifles all told. The C.R.E. 3rd Divn. Lieut.-Colonel C. S. Wilson, C.B. took command and we marched up as a three company Battalion with Wilson and poor Tubby Wells, his adjutant, leading. Wilson was mounted and so was I—quite an unnecessary trimming. It was raining like the devil and as dark as the same gentleman is reputed to be. My Company came first and I rode beside Wilson. The Germans were shelling the Menin Road but not hitting it. One shrapnel burst over our heads like a thunderclap. It was directly over us apparently and the flash in the dark was blinding. I turned round and shouted: "Anyone touched," and the men answered: "None, Sir." So through Hooge until we got to 9th Brigade H.Q. There I stayed with the men in some empty houses until about

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midnight. I believe Singer actually got into a front line trench, Nation, I think, waited with us. At midnight I got the order to go to work and away we went to our old pitch in Herintage Wood. We knew absolutely nothing except that the R.E. had been wanted as infantry and we drew the obvious inference from that. Our work now consisted of improving communications, as the weather had become very bad and the ground was awful. We put down some corduroy road through the woods and this improved matters, but we had neither time, material nor labour to do much. We also worked on supporting points and second line trenches, the latter near Stirling Castle, and, as we had been pushed back a bit on the 11th, we had to readjust our front line. The incident of the stable, recounted above, really took place about this time when our front line actually went through it. There had been a great deal of argument as to the actual design of these supporting points, mainly as to whether they should be wired all round or not. I was discussing it with an officer one night and he was strongly in favour of an open gorge, and to give point to his argument he told me that during an attack on his sector the garrison of one of these points, which was completely and securely surrounded with wire entanglement, had levanted before ever being attacked, as they said the wire was so strong that they would never get away if they did not start at once. It is a fable no doubt but as a fable it is interesting.

I now decided to make my move from the White Chateau and took the Company to Potijze where we got good and quiet billets and horse lines and where, although we could hear the shells going over us, we were never hit. This very place was an inferno during the 2nd Battle of Ypres, but then the Germans were much closer to St. Julian than during 1914, and the shell fire we suffered from at the White Chateau came from the direction of Hollebeke.

The weather continued to get worse—rain, sleet and frost alternating and the filth was indescribable. One night just outside Potijze Chateau I was pushed off the pavé and I sunk to my knees in the mud at the side. How people lived in the trenches I don't know. No one who was not there knows the misery they suffered. However, the 3rd Division's trials were nearly over. They had suffered so severely that they had to be relieved somehow and cavalry were sent up to take a hand dismounted.

To show how depleted the Infantry Battalions were two of the Battalions in the 9th Brigade were down to 3 officers and 140 men between them:

Royal Fusiliers, 1 officer and 60 men.
Scots Fusiliers, 2 officers and 80 men.

The "7th" were commanded by a temporary Lieutenant of about 3 months' service and, far from being depressed about it, he

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seemed to be as happy as a sandboy. I remember on the night I am thinking of, I condoled with him as to the hard lot of the Infantry officers and in reply he laughingly said that, on the other hand, he thought the Sapper Subaltern was much worse off and that he wouldn't have his job for anything.

The Cavalry came up by Brigades and these Brigades were relieved at very short intervals. They worked and fought most splendidly and seemed to take the digging as a sport. I was much impressed by the keenness they all displayed, both officers and men, over work that was not in their line at all really. We had our 3rd officer casualty on the 15th November. Bebb who had relieved Carr at Richebourg L'Avoué was hit on the back of the leg by a shrapnel bullet on his way back through Hooge that morning. I was on the road in front at the time and when he joined me he told me about it. He was limping a bit, but the bullet though it had, he said, rolled him over like a rabbit, had not penetrated his gaiter and he was able to walk home (about 2 miles). He did not go sick for some time though his leg was badly bruised but eventually he had to give in. I met him again in London in 1918 and he told me that he had been laid up for nearly 6 months.

About the 18th rumours were going about of a relief by the French of the British troops in the Salient and we heard definitely later that we were to go out of this line on the 21st. However, there was some delay and we were put off for a day. The British Cavalry had already replaced the 9th Brigade though we sappers were still in the line and the 3rd Cavalry Brigade—4th Hussars—5th Lancers and 16th Lancers were actually in the line on this date—21st.

Early that morning I got a call to Divisional H.Q. where I learnt that the Germans had again taken our stable and that orders had gone forth for it to be retaken that night before we handed over to the French, and finally that I was to go up and advise the Cavalry Brigadier (J. Vaughan) as I had been present at the last performance.

I was riding my old black mare. She was a fidgety old shrew and hated shell fire if possible more than her master did. However, off we started up the Menin Road, my trumpeter in attendance. This trumpeter was a dark taciturn youth, a very good rider and one who feared nothing. When we were out together he always insisted in putting his troop horse over everything that I jumped, going across country even though there happened to be an easy way round. It was a point of honour with him to follow my exact track. As we went up to Hooge along the pavé big black shells began to fall on either side of the road—well clear of it but near enough to be alarming. My mare was mad, the road was slippery and I thought between the gymnastics of the mare and the shells I probably would never reach my destination. However, we arrived at Hooge all

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right and I sent the mare back and went in to see Vaughan. He was out but I saw his Brigade Major, who said the Brigadier was up at Herintage with the Regimental Commander. I started off on foot and found Vaughan and we then reconnoitred the place together—a risky performance and most uncomfortable as we had to do it on our stomachs and the ground was very wet.

It was found impossible to arrange an attack before the relief by the French, and I was told to get my men to work on strengthening the defences and sapping a switch to cut off the stable. I was to stick to this and come away when the French had relieved the last Cavalry Regiment (16th Lancers). About 10 p.m. the French General came in and began to take over. When the case was put to him he smiled, spread out his hands and said it did not matter. So the relief went on and we got away about midnight and back to billets to prepare for our departure. The Frenchman's nonchalance was quite justified. So stubborn had been the defence of the lines by the British Infantry that we got into the way of thinking that every bit of the line was an essential point. We hated to give ground anywhere and did not realise that bending back was quite different to giving way. The frame of mind or point of view was what won the first Battle of Ypres, but it could be hunted to death. When I got back to Ypres in April 1915 with the 27th Division we took over this bit of line from the French and we found that they had never attempted to retake the stable and were quietly holding the retrenchment I had sapped round it the night of 21st November, 1914.

(I notice my diary states the day to have been the 20th but I believe that was a mistake.)

Our next anxiety was to get out of Ypres safely—not an easy business. I ordered an early start, 5 a.m. (22nd). This gave time for food and a little sleep. Everything had been packed up the day before so there was nothing much to do. The weather had turned very cold and it had been freezing hard all night. Our wagons had been standing in liquid mud the day before, and when the teams hooked in about 4.30 a.m. it was found that the wheels were frozen into the ground. Here was a fine kettle of fish. I was anxious to get through Ypres before 7 at latest, as that was when the morning "hate" began, and the delay was annoying. However, we all turned to and hacked the wagons out and got away about 6 o'clock. Down the road to Menin Gate, through the Square and past the Cloth Hall, which then had its roof on, past the Cathedral and out on the Vlamertinge road past the Asylum—not a shell—then a halt. We were very lucky as the 3rd Divisional H.Q. had an exciting passage an hour later. I know I offered up a prayer that I might not have to go to Ypres again. I was there in 4 months for the second act of the tragedy.

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We had great difficulty to get along, the road was covered with glass-like ice and the horses were unroughed and slipping about all over the place. We shoved on, however, and passed through Ouderdom to Locre where we got in about 11 a.m.

The hill on the road from Reniughelst to Locre was covered with vehicles that could not get up on account of the ice. We got through somehow and found rest at last in a smelly billet on the Locre Kemmel road near Locre Convent. Such a relief—we were told we were going to have a rest and we got a short one—before going into the 5th Division line East of Lindenhoek.

I had nearly forgotten my last experience of Hooge. My orderly and I were passing back through the village the morning we left when the Germans began shelling the Cavalry horses that were waiting for their riders just West of the village on the Menin Road. There was a considerable mix up and I saw that the fire was concentrated on the road. There was another way for us across the fields but, as my orderly had a bicycle, I doubted if he could manage it. I said to him: "Do you think you could get the bike along if we took to the fields here," and his answer was: "Just see me try, sir," and try he did and most successfully.

Our total casualties during the 1st Battle of Ypres were:—

	Killed.	*Wounded.*
Officers		1
N.C.O.'s & Men	3	6

I lost one of my best N.C.O.'s (Corpl. Cornwall) on the night of 7th November, shot by a sniper through the body. He died of his wound later on in hospital. Towards the end there were many sick casualties due to the cold and wet.

Another fairy tale—the first night we spent at Locre in our rest billet Johnston and I occupied the same room. I woke up in the middle of the night with the distinct impression that I had been called to turn out. I sat up in my flea bag and was just putting out my hand to wake Johnston when I realised where I was and lay down again. When I told Johnston next morning he replied that exactly the same thing had happened to him that night—so much for overstrained nerves.

Next day the 23rd, we were turned out to be inspected by the G.O.C. of our own Division, General Morland, who had never seen us before. Then it was a case of all hands to clean and badly we wanted it. We were told now that leave had opened and, as the C.R.E. did not want to go, I put my name in. I got it all right and started off on 7 days pass on the 25th November. The bus started from Bailleul at 4 a.m. and by strenuous efforts I managed to reach Kingstown by 5.30 a.m. next morning and was in my own home for breakfast. In my wildest dreams I had never hoped for such good

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fortune. The people in England were kindness itself. One old lady asked me if I was wounded and then said: "Would you not have liked to have a little wound." Another absolute stranger in another hotel insisted on shaking hands and so on. The Canteen ladies seemed so disappointed that one was not dying of starvation. Little did I realise that never again was I to serve with the 59th Field Company R.E. The day after my arrival home I was down with fever and did not get back to France until the 14th December, the day the 3rd Division attacked Wyschaete unsuccessfully. I actually rejoined the Company but went down again and eventually gravitated to Boulogne to Hospital. I escaped going home and got back the first week in January but was kept at 2nd Corps H.Q. to organise the Corps roads, and there I stayed until I went to the 27th Division as C.R.E. in March 1915.

I often saw the Company however—They had moved to the old billet at Dranoutre on the 25th November and started work in the 13th Brigade line East of Lindenhoek. They had a very heavy time and lost poor Flint—killed. He was shot by a stray bullet and died a few hours after. He indeed was à gallant soul—nothing that I can say can do justice to his merits. I went to his funeral in Dranoutre Churchyard and the Corps Commander was there also. The Army Commander, Sir H. Smith Dorrien, who knew him well, wrote to say that only the most pressing duty prevented him coming to pay the last tribute to "the gallant Flint." Sir Charles Fergusson read this letter out to the men and then spoke to them of Flint's example—a most impressive scene. All the old men holding up the example of this young subaltern to the admiration and emulation of the assembly. His grave was marked by a very handsome oaken cross made by the men of the Company. Pennycuick went to look for it this summer and wrote to tell me that the place was unrecognisable. However that matters little—the fact remains that the memory of Flint, as that of his bosom friend W. H. Johnston, will remain for ever with all those who had the honour of serving with him. If we can only follow the example of his short life we shall have done more than well. Before his death he had already won a D.S.O. and the Legion of Honour and was recommended for a V.C.

My story is finished. It may be scrappy and possibly I may have shown an unseemly levity in some places; however, we kept ourselves alive I think by trying to see the humorous side of things rather than the reverse.

What has impressed me most in looking back is not so much the memories of the incidents, exciting though they were, but the thought of how much our successes depended upon the old-fashioned training. First, the training of the officers at school and in the military colleges, a training, the essence of which was the suppression

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of the individual for the benefit of his fellows and, secondly, the training of the men, first in the technicalities of soldiering and then in the belief in his officer, which was the hall-mark, so to speak, of all good regiments. I believe that nothing counts so much in the army as the old-fashioned relationship between officer and man. It was a real brotherhood. The men had a standard which they expected from their officer—knowledge, uprightness, justice, and leadership, and if that standard was attained they would follow him to death quite cheerfully. I believe that standard was attained and I believe that it was this that made our men so steadfast. I remember speaking to the men of the 59th Company on parade at the Curragh just before we marched off to the train on the 16th August. I said to them I had never been let down by a sapper in my life, and that I knew that whatever happened to us they would always behave like gentlemen. I was answered by a growl of " Hear, hear," from the ranks and I knew that I had those men behind me in good and evil times as long as they were alive. Nobly they kept their word. Nothing was too much for them, and never did they waver. I owe them a debt of gratitude that can never be repaid.

I had trained these men for 2 years before the war and had experienced with them my first baptism of fire. They were proud of themselves and I think justly so, for they earned the praise of many. Am I wrong to be proud of them ? We went through much together and they never failed. Am I wrong to believe that the words that Shakespeare puts into the mouth of King Henry V on the morning of Agincourt, are not inapplicable in our case also ?

> We few, we happy few, we band of brothers,
> For he to-day that sheds his blood with me, shall be my brother.

I found the remnants of the old Company at the Curragh last summer reforming. There were only 3 men in the Company all old hands, Sergeant Richards D.C.M., Sergeant Barwick M.M., and Corporal Guinan D.C.M., all good men and true, who will I have not the slightest doubt, well and truly rub into the rising generation the lessons we learnt in the great war. Of them the principal I believe to be that, if you are to command men, in no matter how small a sphere, you must cultivate a soul. Not a soul that is constantly exercised as regards its own welfare, either here or in the hereafter, but one that is always endeavouring to hold up the hands of its less fortunate, but perhaps not always weaker, fellows and is constantly striving to help the lame dogs over stiles.

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SCHEDULE OF MARCHES.

	Distance.	
Landrecies to Bavai	15 miles.	
Bavai to Hainin	12 ,,	
Hainin to Dour	3 ,,	
Dour to Bavai	7 ,,	
Bavai to Reumont..	19 ,,	
Reumont to Ollezy	33* ,,	*(22 hours) 17—*marching*
Ollezy to Pontoise	17 ,,	
Pontoise to Croutoy	17 ,,	
Croutoy to Crepy en Valois	14 ,,	Retreat from Mons.
Crepy en Valois to Ognes	14 ,,	
Ognes to Inverney	8 ,,	
Inverney to Mont Pichet	14 ,,	
Mont Pichet to Gagny	16 ,,	
Gagny to La Celle	17 ,,	
La Celle to Boissy	7 ,,	
Boissy to Champortal	8 ,,	
Champortal to Mery (Marne)	4 ,,	
Mery to St. Quentin	15 ,,	
St. Quentin to Billy sur Ourcq	10 ,,	
Billy to Nampteuil	9 ,,	
Nampteuil to Sermoise (Aisne) ..	6 ,,	

13. 9. 14 to 2. 10. 14.

BATTLE OF THE AISNE.

Couvrelles to Violanes	5 miles.	
Violanes to Longpont	12 ,,	
Longpont to Buy	15 ,,	
Buy to Bethisy	8 ,,	
Bethisy to Pont St. Maxence (entrained)	9 ,,	
Abbeville detrained to Millencourt ..	5 ,,	
Millencourt to Genne Iverney	16 ,,	
Genne Inverney to Rosemont (part by bus)	15 ,,	
Rosemont to Oblingham	20 ,,	
Oblingham to Le Touret	5 ,,	

12. 10. 14 to 31. 10. 14 (fighting round Richebourg L'Avoué).

Le Touret to Vieux Berquin	13 miles.	
Vieux Berquin to Flêtre (Courte Croix)	4 ,,	
Flêtre to Dranoutre	7 ,,	

1. 11. 14 to 7. 11. 14.

Dranoutre to Ypres	16 ,,	

7. 11. 14—22. 11. 14.

Ypres to Locre	10 ,,	
Locre to Dranoutre	2 ,,	
Average No. of miles marched daily ..		11·54
,, (during retreat from Mons) ..		16·9

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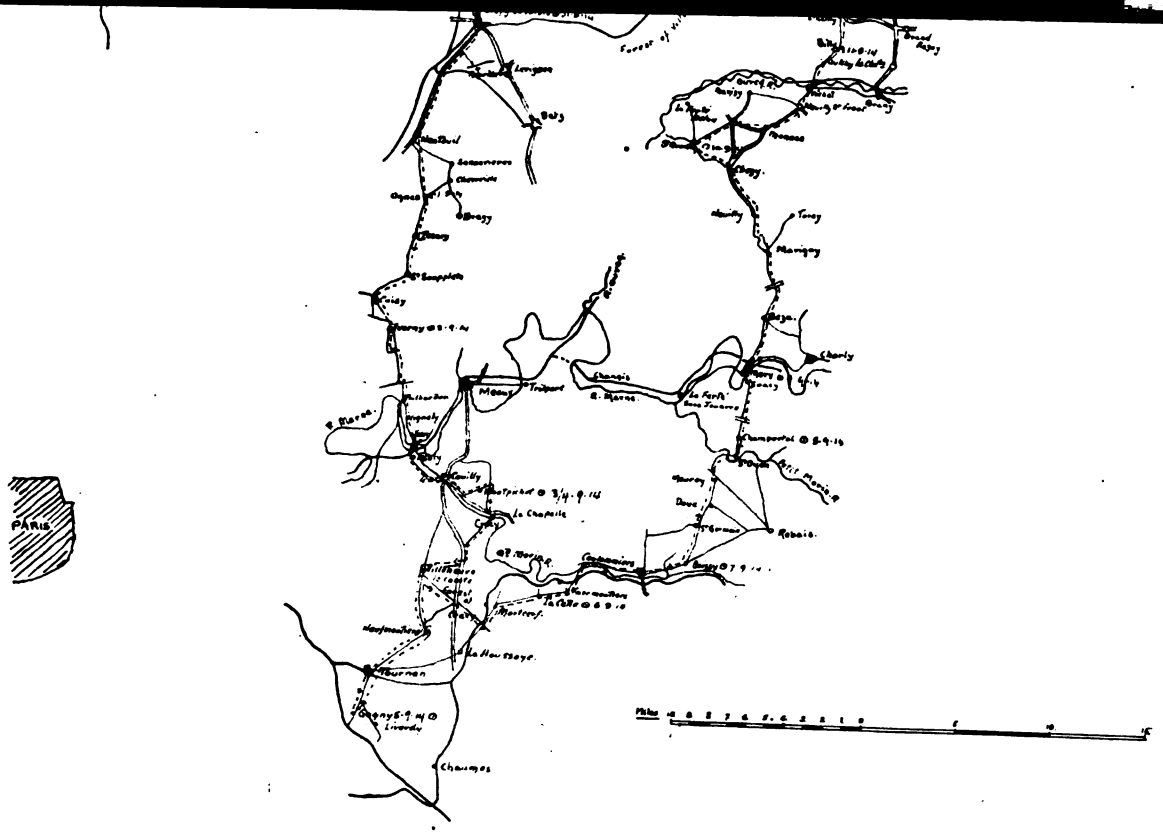
PARIS
Longpont
Montgé
Tournan
Villeneuve-le-Comte
Chevry
Tancrou
Mareuil
Coulommiers
Rebais
Chauffry
Chamigny
Crécy
Meaux
Chambry
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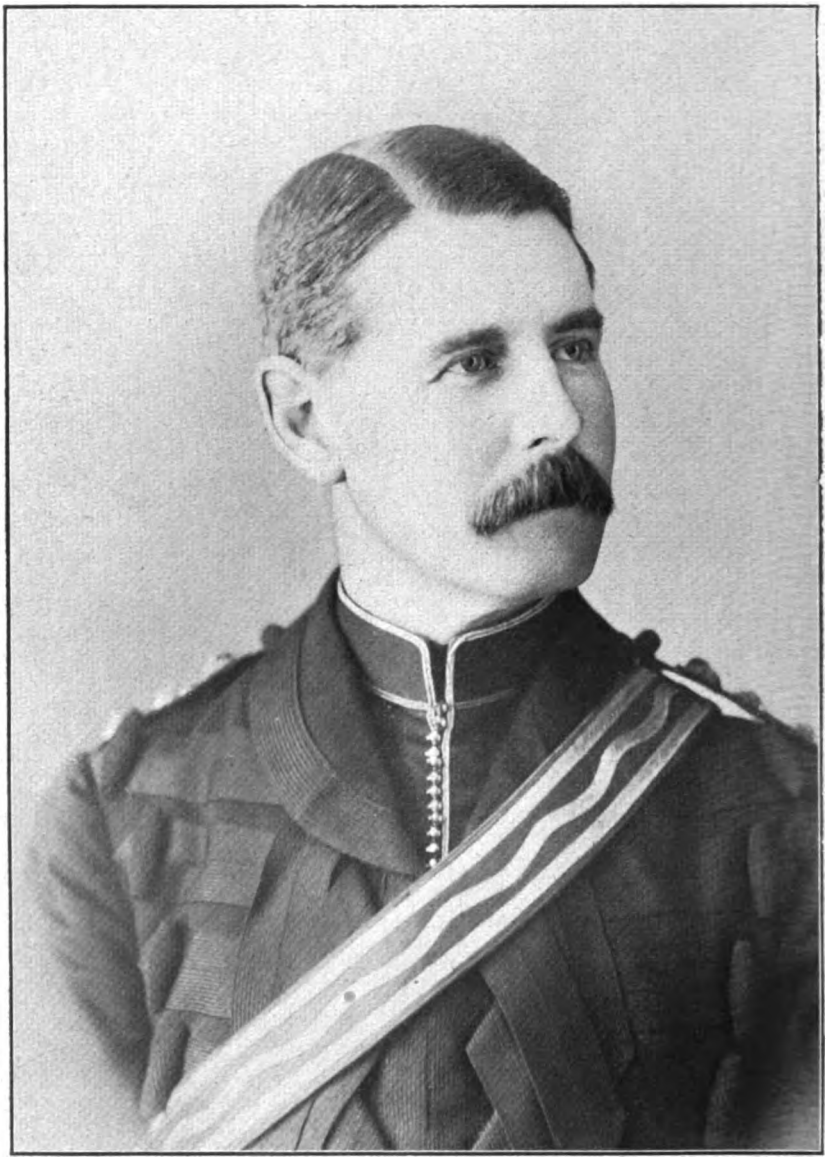

Colonel H. W. Renny-Tailyour.

From a photo by The Falk Studios, Sydney, N.S.W.

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MEMOIRS.

COLONEL H. W. RENNY-TAILYOUR, LATE R.E.

HENRY WAUGH RENNY-TAILYOUR, who was born on the 9th October, 1849, at Mussoorie, N.W.P., was the son of Colonel Thomas Renny-Tailyour, J.P. and D.L., Royal (late Bengal) Engineers, of Borrowfield, Forfarshire. Educated at Cheltenham College (August, 1859–December, 1867), he was in the cricket eleven of 1867, and the *Cheltonian* described him as " a tremendous hitter in his day, though rather uncertain ; also frequently shows good defence ; a magnificent out field, having plenty of dash ; sometimes useful as a change bowler." A very few years later there was no uncertainty about his batting ! At the R.M.A. (January, 1868 to July, 1870) he was in the elevens of 1868, 1869 and 1870 (captain in 1870) ; in the football fifteen 1868 and 1869 ; in 1870 he won the mile and half-mile at the sports, and against Sandhurst was first in the half-mile. Before leaving the Shop he had given a striking example of what was to come afterwards by scoring 106 not out on Chatham Lines, for the R.M.A. against the Corps.

Gazetted lieutenant, R.E., on the 23rd August, 1870, he was at the S.M.E. until December, 1872, when he was posted to Portsmouth ; but in May, 1873, he joined the 4th Company (Submarine Miners) then on board H.M.S. *Hood*, which was moored off Gillingham Pier in the Medway. In February, 1876, he went to Ireland as extra A.D.C. to the Lord Lieutenant, and the following January was ordered to Gibraltar ; after a year there he returned to Chatham for three years, being Assistant Instructor in Telegraphy from May, 1878, to February, 1880. From April, 1881, to August, 1884, he held the appointment of Instructor in Fortifications at the R.M.A., after which he returned to Chatham, as Assistant Instructor in Field Fortification, for nearly four years ; then followed three years at Gibraltar and three years at Sydney, in Colonial employment, as C.R.E. Defences, New South Wales.

The end of 1894 found him back again at Chatham, where he commanded the Training Battalion from August, 1895, to October, 1899, when he retired from the Army in order to take up the appointment of Assistant Managing Director in the Guinness Brewery at Dublin. He became Managing Director in 1913, and on resigning that position last year the following appreciation of his services was

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recorded in the Annual Report to the Shareholders of the Company: "The Directors have to report, with regret, the retirement of Colonel Renny-Tailyour from the Board upon which he has so ably worked for the past twenty years." On leaving Dublin, he went to live at Newmanswalls, Montrose, a property which, with Borrowfield, has belonged to the family for several hundred years. There he spent his time fishing, golfing, and shooting, keenly interested in the garden, until he was quite unexpectedly taken ill and he passed away after a week's illness.

He married, in 1875, Emily, daughter of John Wingfield-Stratford, Esq., of Addington Park, Malling, Kent—she died in 1904. By her he had a family of four sons and six daughters. One son died in Africa and his youngest son, in the Sappers, was killed in action near Ypres in 1914; his eldest son commanded a battery of Horse Artillery in Mesopotamia, and was several times mentioned in dispatches.

The record of his life given above will suffice to show that he was a typical Sapper, well able to more than hold his own at any kind of work, but it is doubtless as a sportsman that "Renny" will be affectionately remembered by those who had the privilege of being associated with him in past years. Before he joined at Chatham in 1870, there were cricketers in the Corps who had made names for themselves among the amateurs of the day—Fleetwood Edwards, S. Reid, Waller, and Jim Fellowes, to mention only a few—but everyone will admit that to him was mainly due the raising of R.E. cricket to a position which it had never occupied previously and which has been so well maintained since. It was not merely by his own contributions to the score sheets, large as they were, but his keenness in the field was infectious, and made everyone play the game to the best of their ability. He filled the position of Captain of the Eleven, with a few brief intervals, over a period of 17 or 18 years. In the years 1871–75 inclusive, his average each season was never less than 40, and in 1875 he had an average of 50; there were at that time no boundaries, practically speaking, on the Lines, and every hit had to be run out. In 1873, he was at the head of the batting averages, 46 for 31 innings, and he took 62 wickets with an average of less than 13 runs per wicket. He played for the Gentlemen against the Players in 1873, and for Kent occasionally in 1873 and 1874, but he never accepted an invitation to play in outside matches if his presence was necessary in the R.E. team.

At football he had the almost, if not quite, unique experience of representing his native country, Scotland, under Association and Rugby rules; for the Corps he took part in the Association Cup matches of 1872, 1873 and 1874 (two finals), playing centre forward.

He excelled, not only in athletic games, but he was also a good shot and fisherman—an all-round sportsman of the best type.

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Although not given to making great friendships quickly, all who were his intimate friends found in him a cheery, high spirited companion, upon whose absolute loyalty they could count at all times and under all circumstances. It may interest some who read this very inadequate memoir to hear that he retained to the last his almost boyish spirits, on occasions.

A LIFELONG FRIEND.

COLONEL W. J. BYTHELL, C.B.E., LATE ROYAL ENGINEERS.

WE regret to announce the death of Colonel William John Bythell, C.B.E., late of the Royal Engineers, which occurred at a nursing home at Southsea on the 30th of June last.

Colonel Bythell was the only son of the late Colonel Bythell, of the Bombay Staff Corps, and of Mrs. Bythell, Stoneycroft, Southsea, and was born on the 9th of September, 1862. He was educated at Newton Abbott and at the Royal Military Academy, into which he passed in 1880.

He was gazetted to the Royal Engineers on the 25th July, 1882, and after a short period of service at Chatham was selected, in 1884, for special duty with the Topographical and Intelligence Branch in Bechuanaland under Major-General Sir Charles Warren by whom he was honourably mentioned in dispatches.

He was posted to the Indian Establishment in October, 1886, and joined the Bombay Sappers and Miners, being transferred later to the State Railway Department, in which he served for nearly two years. In May, 1889, he was posted to the Survey of India, in which Department he served until his retirement in 1916. In the Survey of India he soon acquired a reputation as a Military Topographer of outstanding merit and whenever a Survey Officer was required for frontier work Bythell was always one of the first to be selected. He served in the Chin-Lushai Expedition of 1889–1890 under Colonel V. W. Tregear, in the Chitral Relief Force (1895) under Lieut.-General Sir Robert Low, in the Mohmand Field Force (1897) under Major-General E. R. Elles, and in the Tirah Expeditionary Force (1897–98) under Major-General W. P. Symons. He was mentioned in the dispatches of all these Commanders and for his services, was promoted brevet-major and received the two Indian Frontier Medals with clasps for Chin-Lushai, 1889–90; Relief of Chitral, North-West Frontier, 1897, and Tirah. After serving as Assistant Surveyor-General he was appointed Superintendent of the Northern Circle, which appointment he held until he finally left India.

On returning to England he was re-employed and served as Recruiting Officer in the Southern Command, and in the Chemical

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Warfare Department under Major-General Thuillier, and was made a C.B.E. for his services. It was while employed in this department that he contracted the gas poisoning which laid the seeds of the disease from which he eventually died—a victim of the great war as surely as those who gave up their lives in Flanders.

Apart from his professional career, Colonel Bythell enjoyed a reputation as an artist of no mean order, and his landscapes and pictures of battleships were well known and admired, both in this country and in India. Shortly before his death he was awarded a medal by the Royal Institute of Water Colour Painters. He was a fine cricketer, and played for his Corps in the early eighties. Fond of shooting, perhaps fishing was his favourite recreation, and he had few equals either with the mahseer in India or the salmon in Scotland. At one time an enthusiastic Mason, he took high degrees in the Craft. Few officers had a larger circle of friends than "Willie Bythell," and by his untimely death the world is the poorer of a good sportsman, a loyal friend, and a most devoted son.

He was laid to rest in the pretty churchyard of Christchurch, Purbrook, on Portsdown Hill.

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CORRESPONDENCE.

MAJOR A. ff. GARRETT, O.B.E.

To the Editor, R.E. JOURNAL.

DEAR SIR,—I have read with great sorrow the account of the career of Major Garrett, and I should like to offer a sincere tribute to the memory of so admirable and distinguished an officer, and to state that, in my opinion, not only the Corps, but the scientific world, has lost in him one of its most rising men. He passed through my hands when I was Instructor in Construction at the S.M.E., about 25 years ago, and I regarded him as one of the very best of the many talented young men with whom I was then brought in contact. Later on, in India, he used to correspond with me about his remarkable researches into the theory of arched masonry dams, which he carried into practical effect with so much economy and success in Rajputana. He subsequently sent me his diagrams about the discharge of water in channels, in connection with which his name will be always associated, and which seemed to me to be an admirable embodiment of scientific skill and practical knowledge. Had he lived, he would have risen to the very highest rank among hydraulic engineers.

His life was given without stint to the service of his country, and while we mourn his loss, we look back with pride and admiration to his achievements.

I am, yours faithfully,

G. K. SCOTT-MONCRIEFF, *Major-General.*

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REVIEWS.

DICTIONARY OF EXPLOSIVES.

By ARTHUR MARSHALL, A.C.G.I., F.I.C., F.C.S., Chemical Inspector, Indian Ordnance Dept. (Messrs. J. and A. Churchill). 15s.

Its title sufficiently indicates the object of this book, which has been arranged as a handy work of reference for those dealing with explosives. It contains a very complete list of all explosives now in general use, giving the composition and a brief description of each. Lists of explosives are given, classified as coal mine, blasting, and propellent; these classes being further sub-divided according to country of manufacture. An index of constituents is also included, which shows at a glance all the explosives in which each particular constituent is used.

ELECTRIC WIRING—THEORY AND PRACTICE.

By W. S. IBBETSON. E. and F. N. Spon. Price 18/- net.

The second edition of this book, which has been published this year, is decidedly more comprehensive than the old edition and can be recommended to those employed on electrical installation work. Considerable trouble has been taken to present the matter from the practical point of view, and the new chapter on "Motor Circuits," detailing as it does the characteristics and applications of all classes of motors, will be found distinctly useful. Systems of wiring and methods of installing the wiring are well described, although the possibility of using connectors to save long loops has been but lightly touched upon. A special chapter is devoted to the problem of steep wiring, and there are a number of useful appendices. The book is specially adapted to the use of students taking the City and Guilds of London Institute examinations in installation work, and a number of questions from these examinations are given at the end.

G.T.

HOW TO OBSERVE IN ARCHÆOLOGY. Printed by the Trustees of the British Museum. 2/6.

This little handbook should prove of the highest value to officers stationed in the Near or Middle East, both to those who are already interested in the study of archæology and also to those "who are not interested in the subject, but coming into possession of antiquities may unwittingly do incalculable harm by allowing them to be destroyed

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or dispersed before any record has been made." In the introductory chapter it is stated that "most, if not all, of the countries with which we are concerned, have their Laws of Antiquities. It cannot be too strongly insisted that these laws, even if they might be better than they are, should be obeyed by the traveller." Individual objects may form whole pages of history, whether of politics, arts or civilization, and half or more than half of their scientific value is lost if the sources from which they are obtained are not intelligently recorded. The essential value of antiquities, apart from their purely artistic interest, lies in the circumstances in which they are found. "For the same reason anything like unauthorized excavation, especially by unskilled hands, is gravely to be deprecated. To dig an ancient site unskilfully or without keeping a proper record is to obliterate part of a manuscript which no one else will ever be able to read." The book is profusely illustrated, showing specimens of pottery, weapons and inscriptions.

F.E.G.S.

IMPERIAL MILITARY GEOGRAPHY.

A Lecture by VAUGHAN CORNISH, D.SC. (Sifton, Praed & Co.) 1s.

This pamphlet may be safely recommended for the use of officers who are preparing lectures on the subject.

F.E.G.S.

THE LAWS OF HIGH SPEED PUNCHING WITH PARTICULAR REFERENCE TO THE PERFORATION OF ARMOUR BY PROJECTILES. By Capt. T. J. TRESIDDER, C.M.G., late R.E.

In the case of slow moving punching presses such as are used for the perforation of plates, the following law obtains, viz., energy expended varies as Dt^2 where D is the diameter of punch and t the thickness of the plate.

In the memoir under review Capt. Tresidder investigates whether the same law obtains in the case of the perforation of armour plates by projectiles, and he has shown that substantially it does.

The whole subject is very lucidly treated, as might be expected of such an authority on ballistics as Capt. Tresidder, and the memoir is not very difficult reading.

In the Appendix there is a summary of the long-fought-out duel of guns *versus* armour, and Capt. Tresidder points out that it is the projectile which is the weak point of attack, and that if this can hold together no armour of practicable thickness will resist penetration at any but extreme ranges. The reasons for this will be found by studying the memoir, which should be of considerable value to artillerists.

J. M. WADE, *Lieut.-Colonel.*

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NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 104.—*Infantry Equipment in the Light of War Experience.*—Capt. Stephanus compares the simple weapons with which the infantry began the war and the armoury with which it was equipped at its close. The infantry was not adequately prepared either technically or tactically at the beginning of the war, but every war brings surprises and the longer the preceding peace the more there are. After a successful war all lessons are quickly forgotten but not after an unsuccessful one. The old regulations called the infantry the "Queen of Battles," but did not train it properly or give it adequate support from artillery or machine guns. The attack was studied too much, and the defence neglected, with the result that faulty fire tactics were adopted. The victories at the beginning of the war were won through the overwhelming moral superiority of the Germans, and in spite of their fire tactics. When the trench war began the long neglected individual shot began to be recognized at its proper value, but the effects of faulty peace training were not easily eradicated, and every infantry officer knows how difficult it was to get men to seize fleeting opportunities and to shoot without waiting for the accustomed words of command when favourable targets presented themselves. Artillery and machine guns were multiplied enormously, and as trench war became more and more rigidified the absence of visible targets caused the rifle to be relegated more and more to the background, while grenades and trench engines of various sorts were increasingly used.

The Plundering of German Brains.—Capt. Gadow, of the German Navy, notes with great anxiety a tendency on the part of Germans to believe what the Entente tells them. This will never do, and he whips up their flagging hate by describing the action of the various Commissions of Control. These, not content with supervising the destruction of German war material, are actually collecting information regarding its construction and its use. He comforts himself by reflecting that the brains and hands which produced these inventions in the past can make better ones in the future and looks with contempt on the victors whom fear, jealousy and curiosity compel so to search through the ruins of German power.

A choice collection of extracts from various French papers is given in order to show that the Allies are quarrelling, that Alsace hates France, and that France wants to utilize the troubles in the Ruhr district as an excuse for the partition of Germany.

German officers of the Reserve domiciled in Alsace may, if they wish, enter the French Army as 2nd Lieutenants, but ex-active list officers can only come in as private soldiers with the chance of promotion if found deserving. This is justified by the French on the grounds that an active

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list officer entered the German Army because he wanted to, but the reserve list one because he had to.

No. 105.—*Infantry Equipment in the Light of War Experience (continued).*—The attacks of 1915 showed on both sides the same characteristics; artillery and machine-guns undertook the provision of covering fire and the peace-time spectacle of mutual support between infantry units was never seen. The expenditure of rifle ammunition fell very low, and to read the daily *communiqués* with their perpetual "attack was repulsed with artillery and machine-gun fire" one would imagine that no such weapon as a rifle existed. Yet it would be quite wrong not to consider the rifle as the chief weapon of infantry when its use is properly taught. It was here that the fault lay; no German had ever fired his rifle at a range under 200 to 300 metres, and so he left the fire-fight to the machine-gunners and replaced his rifle with a hand grenade. Attempts to alter this were made during the war, but too late. The light machine gun had to be introduced to do the work which the heavy one could not and the rifleman would not perform, but it could not do so properly. Its fire effect was far from equalling that of the heavy, and its weight, awkwardness and the size of its crew were further drawbacks. Hence came the machine pistol, which, however, was only effective up to 200 metres and of which the ammunition was at times faulty. Tanks in ever-increasing numbers next made the anti-tank weapon a necessity—one more "special" weapon. Last came infantry guns and very useful, in fact essential, they have proved themselves to be; an extended use of them is to be expected. The writer considers that the aim of future research should be to produce a simple grenade which can be projected either from the hand, or the rifle, and a weapon which shall combine the qualities of the machine gun, the rifle and the machine pistol. That is to say it must be a handy self-loading weapon with a useful range up to 1,000 metres; it must be as good for single shots as for bursts of fire; its ammunition must be light and simple. The bayonet cannot be left out; its moral effect, both on the enemy and on the man himself, is too valuable. He concludes that a thorough training in snap-shooting with fixed bayonet will be necessary in the future and emphasizes the necessity for simplifying the armament of the infantry man for training reasons, for, although with their present 12-year man this is not so important, with the *masses of recruits which may one day confidently be expected,* it will be a main consideration.

No. 105.—*The Intelligence Service, the Press and Public Opinion during the War.*—This book by Lieut.-Colonel Nicolai, who was head of the German Intelligence service at General Headquarters, is fully reviewed. It is stated that weakness of the German system lay in inadequate peace preparation, as against the lavish expenditure of the Entente. Counter-espionage met many difficulties, of which the lack of uniformity in the various German State police systems was one of the greatest, particularly when the Entente propaganda set to work in the political and economic life of the country. On the purely military side he claims complete success. Other chapters deal with censorship and *communiqués,* and discuss the difficulties which the politicians caused by making General Headquarters do the work which they themselves should have

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undertaken. As Colonel Nicolai served under Moltke, Falkenhayn, and Ludendorff an adequate account of his activities should prove of considerable value.

Yugo-Slavia.—Even the *M.W.B.* cannot withhold its praise from the Serbian Army ; the first to mobilize, it was the last to demobilize. Before mobilization it had undergone two severe campaigns, and at the very end of the war was allotted by the Entente the heaviest burden in the Macedonian operations. Its losses are variously estimated at from 500,000 to 900,000 out of a total population of barely four million souls. Typhus accounted for an immense number. After the great retreat, and when emigrants from America had filled the ranks, only six weak divisions and a half mounted cavalry division could be formed. In spite of this the new State is forming a large and essentially Serbian Army, for former Austrian elements are not encouraged, unless of definite Serbian sympathies and speaking a South-Slav language. It will eventually amount to 24 divisions and, in the infantry, service with the colours will be from 14 to 15 months.

No. 106.—*The French Army and Disarmament.*—The writer does not think the contemplated establishments of the French Army show many signs of disarmament. The figures aimed at for 1st November, 1920, are 550,000 white and 195,000 coloured troops. It is thought probable that the first figure will not be attained, in which case more coloured troops will have to " bring their skins to France for sale." France feels she cannot rely on England, Italy or even America for help, and is determined once and for all time to be in a position to beat Germany single-handed. The French say " Disarmament is absurd, no one but the credulous German Michael would be so foolish as to imagine such a thing. Let us prepare, so as to be ready at all times not only to push forward our imperialistic plans in Africa and Asia Minor, but also to keep Germany down in the dust."

Regimental Associations.—Major Steuer, president of the Officers' Union, advocates the adherence of regimental associations to a central organization which should be built up as soon as possible.

Officers' Pensions.—A demand is made that the pensions of officers of the old army should be paid in gold marks, which are estimated at 10 times the value of paper marks. The claim is based on the fact that pensions are really deferred pay and that, as the pay, of which payment was deferred, was in gold marks it is sheer betrayal to issue it now in an equal number of paper marks. One seems to have heard very similar arguments in this country. Another appeal on the same subject points out that a recruit now receives more in pay than a Lieut.-Colonel, retired, after 35 years' service, does in pension, and a young lieutenant more than a pensioned divisional commander. The result is that the son has now to make his father an allowance. Changes are said to be under consideration, but the writer does not hope for any great improvement ; it appears that the usual giving with one hand and taking with another is likely to result.

No. 107.—A brief summary of British Army and Navy estimates receives the comment that they, too, show very little sign of disarmament.

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Official Notices.—Government employees are to receive pay during the great general strike, provided they reported for work on Monday, 22nd March. Any Government employee who joined the "Einwohnerwehr" or "Zeitfreiwilliger" or other emergency organizations for maintenance of order, is not to be dismissed for that reason. His absence is to count as absence on leave.

Reviews of Books.—"Four Years War in German East Africa," by Arning and "The Austro-Hungarian Share in the War," by General von Auffenberg-Komarow are both well reviewed.

"Bestiality in the World War" is another of the "hate" books now being published, probably as a counterblast of the Leipsic trials. British and French are accused of the most terrible cruelty to all who fell into their hands.

Roll of Honour.—Reichswehr Rifle Regiment No. 61.—9 officers and 28 other ranks killed during the March troubles.

No. 108.—A farewell order announces the disbandment of the German Army Reserve and thanks all who served in it for their great deeds during the war.

Germany Must Disarm!—The leading article protests against this ruling. After enumerating the progress made in destruction and surrender of material, the writer expresses the view that an army which is not built on universal liability to service contradicts every principle of democracy. He thinks that the British Army only manages to exist by reason of the opportunities it has for employment overseas, and that it is illogical and wrong in every way to impose the British system on a State which has to exist under entirely different conditions. The fear of a repetition of the Scharnhorst methods of building up a reserve, if a conscript army is allowed, is declared to be groundless, owing to modern conditions. No reason is, however, given to show how these conditions affect the case. The existence of secret stores of arms is denied, and it is declared that Germany is loyally trying to carry out the terms of the treaty and that no one is more desirous than the German Government to collect the weapons now held, without authority, by the populace. Rumours of secret arsenals are started by profiteers and radical elements who wish to see Germany even more powerless than at present.

The Roumanian Army.—Roumania as now constituted has a population of 15½ millions, and can therefore maintain double the army she could before the war. At present she has 35 divisions, an increase of 13 on the number with which she entered the war. These are not yet demobilized but are maintained on a low establishment, liberal leave being granted. Arms and equipment are good, but not quite sufficient as yet, though much has been got from Hungary. Roumania appears to have treated ex-enemy officers in an exemplary manner. Loyalty to Austria and Hungary during the war is rewarded and traitors to their country are not welcomed by their new compatriots. Ex-enemy officers are freely posted to the new Roumanian Army which, in consequence of this liberal policy, is rapidly settling into shape.

No. 109.—General von Freytag-Loringhoven's book "Heerfuhrung im Weltkriege" is reviewed. The sound doctrine which Germany brought into the war is to be attributed to a great extent to the teachings

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of the author during his 25 years' service on the General Staff. He knew how to read history, and understands in this book how to give events their proper historical consideration and to draw correct conclusions from them. The book appears to be one which will repay study.

The subordinate *personnel* of the German navy appears to be in a very rotten condition. During the March disturbances the under-officers got quite out of hand and threw many of their superiors into prison for several days. The forces which are working for Bolshevism found willing tools in many of the sailors, who do not appear to understand that, by their action, they are not only destroying their own profession, but by quenching all hopes of a modest navy ever being reconstructed, are doing England's evil work for her.

No. 110.—*Mounted Attacks by Cavalry in the War.*—Major-General von Poseck quotes a number of instances to disprove the allegations that German cavalry were shy of attacking when opportunity offered. The actions, or inactions, which he mentions prove nothing, one way or the other, but the following description is curious: "1. 9. 14. Fight at Néry. Mounted attack of the 18th Cavalry Brigade in several waves on English infantry, which threatened the left flank of the 4th Cavalry Division. The enemy was over-ridden and his attack brought to a standstill."

The Belgian Army in 1920.—The Flemish-speaking Belgians are getting more consideration than formerly and at several military training establishments Flemish is the official language. The *M.W.B.* notes this as indicating a weakening of French influence. Elsenborn, the former great German training camp near Malmedy, has been taken over by the Belgians for musketry and artillery training.

The Dutch Army in 1920.—The danger of Bolshevism penetrating through Germany to Holland is remarked, and Holland has strengthened her frontier troops accordingly.

No. 111.—In "The State, the Army and the People," an anonymous author contributes a carefully considered article on the present situation. "Before the 13th March, Germany was beginning to recover, at any rate so far as the peace terms permitted. Work was improving and a fair output of coal being obtained. The publication of Keyne's book had also raised some small hopes of a revision of the treaty. With the events of March everything stopped dead; France began again to speak of fulfilling the treaty to the letter, and the one pillar of the State, the army, began to crack. The participation of a small portion of it in the 'putsch' was arranged, and then suspicion was thrown on all the rest, until the minds even of the middle classes were turned against the army and particularly against the officers. The Communists and Spartacists very nearly came into that inheritance of ruins which they have so long sought. The grounds on which they could have based their hopes were the effects on the army, first of the revolution and, secondly, of the treaty. The Government, except for Noske and the President, treated the army and particularly the officers with the utmost folly and the basest ingratitude. Then, having got it into a thoroughly discontented condition, they exposed it to the influence of every politician in giving it free voting rights. Communists tried to spread into the barracks the idea of further

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revolution. While the reactionaries worked for the re-establishment of the old *régime* the middle party did practically nothing. These political strivings succeeded in widening the gulf between the officers and the men and, by destroying any mutual confidence which the disastrous Soldiers' Councils *régime* had left, in cutting away the foundations of strength in the army as a whole. Under these conditions, what wonder that some officers arrived at the conclusion that they must work out their own salvation, and that if they didn't help themselves, no one else was likely to do so? The other factor which made the Kapp 'putsch' possible was the peace treaty, with the reduction of the army to 100,000 professional soldiers, with no colonial service to look forward to and nothing but politics to offer any change during their 12 years' service. This, together with the uncertainty hanging over everything, brought about the Kapp affair, and now the first thing that is required is the restoration of the sanctity of the oath of allegiance and fidelity to the Constitution."

Officers' Unions.—The organization of officers' unions and their co-ordination with each other is not going quite smoothly, but the fact that this is so, is more a sign of lively interest in the question than of any inherent defects in the movement. Several rival schemes, some of them partly matured, are in the field, but though their methods and organizations may vary, their objectives all lie, at a greater or less distance, in the same direction. A solid and powerful combine may be expected in the course of a year or so.

No. 112.—*The State, the Army and the People* (*continued from No.* 111).—The question as to whether an officer or soldier favours a republic or a monarchy should have no more effect, on his position in the army, than his religion, and he should not have to declare his feelings on the subject. If he is obliged to do so then the most valuable elements of the army will be lost to it, since no man can reasonably be expected suddenly to change his opinions regarding a *régime*, which he has been brought up from his earliest days to reverence. If the officers' corps is destroyed then the whole army is destroyed, for the non-commissioned officers can no more replace it than the workmen can take the place of the management in a business. By all means let competent non-commissioned officers aspire to commissions, but let it not be assumed that the work of an officer can be learnt over-night. The pretensions of the workers to the sole right to control the army can by no means be justified; the peasants and bourgeois have just as much claim to a voice in the matter, but no one in authority except Noske and the President seems to recognize that the Reichswehr is the mainstay of the State. Reforms are certainly necessary and a closer touch between the officers and modern conditions must be brought about; the most valuable officers will be the first to perceive that new methods must be adopted to make the army a true expression of the national instinct. The force of public opinion, and with it, the public Press, must be considered. Such consideration does not imply that the officer should not form his own opinions and act up to them, but that he should in forming them, recollect that other people have opinions and points of view as well as himself. The soldierly virtues of honour, obedience, comradeship and discipline can never be dispensed with, and the soldiers' trade and life,

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at any rate up to a certain rank, must necessarily be a rough one, but the attacks on the army are based, not on these facts, but on the isolation and separation of the army from all sympathy with other forms of national life. The civil war of March only served to accentuate this isolation and much time will be required to heal the wounds then inflicted. Many circumstances combined at that time to make the task of the officer a difficult one, but it is admitted that his conduct was not faultless. The war had left so many officers who lacked the disciplinary training of pre-war days that this was only to be expected. But if Germany is not to be totally destroyed—and another Kapp affair would finish her—the army and the people must build up a mutual confidence and trust in each other. Only thus can the German State continue to exist.

Officers and the Press.—Lieut.-General von Winterfeldt asks why the Press and particularly the *Vorwärts*, which is a Government organ, is permitted to publish so much "hate" against the officers. Two prominent members of the Government, presumably with the concurrence of their colleagues, officially thanked the Reichswehr for their services during March and thereby justly honoured those who fell, of whom the number of officers was out of all proportion large. He can only conclude that these incitements against the officers are published with the connivance of the Socialists, since these have always prided themselves on their party discipline, and that the *Vorwärts* knows that the articles suit the book of the Government very well, though it would not do for them to admit this openly, owing to the effect on the Reichswehr.

Heligoland.—The programme of demolition which is to make Heligoland into a seaside resort and nothing else is outlined. Some 500 men are employed on the work, which began in April last, with the destruction of the airship sheds and batteries and will continue till April, 1923, when the English mission will be able to report to London that the island is of no use even to such a diminutive navy as Germany's. The harbour, etc., cost 80 million marks to construct, and it would be interesting for the tax-payer to know whether its destruction will come to very much less.

Official Notices.—The wearing of party colours in any form by the Reichswehr during the forthcoming elections is forbidden. Anyone painting them on his steel helmet will be dealt with for damaging Government property!

A list of Regimental Unions is given, bringing the total up to 100.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE SUISSE.

No. 4.—*April*, 1920.

THE NEW HUNGARIAN ARMY.

Capt. Cuno Hofer, the author of the original article, points out that Hungary now possesses on Magyar soil its first national army since the days of the Turkish conquest. It was in February, 1919, that a handful of officers of the old Hungarian Army succeeded in organizing a Society

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the main object of which was to prevent their country from going to ruin through disintegration. The President of this Society was Gyula de Gömbös, an extremely energetic officer of the General Staff; he laid in this Society, named the Magyar Orszâgos Véderö Egyesület (Society for the Protection of the Homeland), or shortly the "Move" (from the initial letters of the full title), the seeds from which has sprung the new Hungarian Army. Böhm, the Minister for War, attempted to dissolve the "Move"; however, it managed to survive the persecutions of the Karolyi clique, until the unhappy adventurers forming this clique, finding themselves powerless under the then prevailing circumstances, surrendered themselves into the power of Bela Kun and his party. With the advent of the "Red Terror" (March 21st, 1919), the leading spirits of the "Move" escaped to Vienna and formed the anti-Bolshevik Corps of Hungarian officers; for their Chief they chose a man whose name was familiar to all in connection with the distinguished part he had played in the War, namely, Admiral Horthy. It is Admiral Horthy who has saved his country from falling under the domination of the Bolsheviks and who has, at the same time, organized the new army which has come into existence in Hungary, since the power of the Central Empires crumbled away in 1918.

Notes and News.

France.—A special correspondent contributes notes relating to some of the more important matters affecting the French Army. He points out that the fighting value of an army depends on three essential elements:—The preparation of the troops both as regards their material as well as their morale; the range of knowledge possessed by its General Staff; the personalities of its leaders and superior officers. It is because the last of these elements is the most important of the three that the French Goverment has begun its re-organization of the army by dealing with matters affecting its Higher Command. On January 24th last, a decree was signed relating to the organization of the *Conseil supérieur de la guerre* and the General Staff. The effect of this decree is to continue in force during peace time, under the authority of the War Minister, an organization practically identical to that which was in force during the final phase of the war. It is pointed out that there can be little wrong in a system which, under a democratic *régime*, has produced such men as Joffre, Nivelle, Pétain and Foch in the ranks of the Generals; and such men as Messimy, Millerand, Galliéni, Painlevé and Clemenceau as holders of the portfolio in the Ministry of War. Under the new organization the Commander-in-Chief of the French Army will, in peace time, take the title of Vice-President of the *Conseil supérieur de la guerre.* The *Conseil supérieur* will be under the presidency of the War Minister and will consist of the Marshals of France and not more than ten Divisional Generals, including the Chief of the General Staff; all the military members have full voting power. The members of the *Conseil supérieur* are appointed for one year at a time only. For 1920, the *Conseil supérieur* will consist of Marshal Pétain, as Vice-President, Marshals Joffre and Foch and Generals Humbert, Maistre, Berthelot, Guillaumat, Nivelle, Mangin, Debeney, de Boissoudy, Degoutte and

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Buat—the last named has been appointed Chief of the General Staff. Of these 13 members, three belonged originally to the artillery, one to the Engineers and the remaining nine are all ex-infantrymen.

No. 5.—*May*, 1920.

RE-ORGANIZATION OF THE INFANTRY ARM.

Major Schmidt, the author of the original article, opens his contribution with the observation *piscem natare doces*, but points out that he has no desire to adopt the rôle of a preceptor. He devotes his attention to the views expressed in some of the literature, published since the outbreak of the Great War, in which the subject of the infantry combat has been dealt with. In the part of the article contained in the number of the *Revue* under notice, he deals with the influence of the weapons in the hands of the soldier and with the infantry combat. He directs attention to the fact that in every war new tactical formations have been introduced, and that, in every case, such changes as have, in the past, taken place in battle formations have been dictated by the progressive developments which have taken place contemporaneously in the arms with which the opposing armies have been equipped. Major Schmidt points out that the organization of the infantry company, which at the outbreak of the Great War in 1914 was based on the assumption that the chief requirement in the battle would be a line of skirmishers to produce an effective development of rifle-fire, was considerably modified by 1917, mainly in order to enable the infantry to make the most efficacious use of the new weapons placed in its hands. An outline of the organization of a French infantry company in 1917 is given in the original article, and also that of a German infantry company about the same period. In both cases, by this date, a part of the infantry company had been converted into machine-gunners, whilst another part had become bombers, flame-throwers, moppers-up, etc. Full-page diagrams are given showing the normal attack formation of a French infantry company (on a front of 200 metres), and also that of a German infantry company after the new organizations had been introduced. Major Schmidt draws the following deductions from the developments in the armament of the troops during the Great War :—

1. The machine-gun has become the principal weapon of the infantry.
2. The rifle and the hand-grenade are the indispensable accompaniments of the machine-gun.
3. The rifle can no longer play the lone hand on the battle-field, but must co-operate in the completest unison with long-range and trench artillery.
4. Defensive weapons (*i.e.*, the bayonet, the steel-helmet, the gas-mask, the spade and shovel, etc.) have justified their existence.

The subject of the infantry combat is introduced by a reference to certain remarks made by an officer at one of the Schools of Instruction for American officers in France ; this officer pointed out that the soldier had, since the beginning of the Great War, so completely acquired the habits of the mole, that the old type of attack practised in field warfare

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could no longer be reckoned among the practical methods of present-day tactics. Major Schmidt is not to be numbered among those who have come to the conclusion that in the wars of the future, belligerents will resort almost exlusively, or mainly, to trench war; he is a firm believer in Marshal Foch's doctrine that *the law of strategy is movement*. He sums up his views on the subject in the following terms:—

1. Developments in the armament of troops impose corresponding developments in the tactical domain.

2. Developments in the armament of troops have resulted in the machine-gun becoming the chief weapon of the infantry.

3. Manœuvre is still the essential element in the decisive action.

4. The closest co-operation of every type of projectile-throwing weapon has once more proved to be the most important requisite in the tactical handling of the combined arms.

5. Infantry remains the queen of the battlefield, but must increase its mobility. (*To be Continued*).

The Rôle of Engineer Troops in the World War.

Colonel Lecomte's article on the above subject begun in the *Revue* for March, 1920 (*vide R.E.J.* for July, 1920), is concluded in the number under notice. He states that he is not prepared to put forward definitive proposals relating to the organization, etc., of the Engineer arm as a whole. There are certain matters, however, which, in his opinion, should receive early attention. Colonel Lecomte advocates the formation of a "Signal Corps," which should be responsible for the services connected with every type of electric telegraphy, and should include flag signalling within its domain. He considers that the organization of a national army should be framed from the point of view of defence, and not that of offensive warfare. The mission of the Engineer arm should be to prepare defensive zones; the works to be carried out by them being:—(1) The organization of the frontier defences; (2) the destruction of the communications in front of the prepared positions; and (3) the improvement of the communications in rear of the prepared positions. He recommends that there should in future be five categories of Engineer troops in the Swiss Army, in place of three as at present, viz.:—(1) Infantry pioneers, one company per brigade; (2) Field Companies of Engineers, one battalion of two to four companies per division; (3) Mountain Companies of Engineers, one company per brigade; (4) Mining Companies, one company per division; and (5) Bridging Companies. Colonel Lecomte urges that Engineer officers should be employed in the higher positions of the General Staff. He points out that Engineer officers are not necessarily specialists with a narrow outlook; indeed, the Engineer arm furnished during the Great War, at least, two notable leaders, men of broad views: Kitchener and Joffre.

Notes and News.

France.—A special correspondent deals with the military situation in France. The principal difficulty at the present time seems to be to find the men for the French Army on a peace footing. It is felt that without

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men in the ranks in sufficient numbers, it is impossible to train capable generals to command in the field. At the present time three classes of men are serving with the colours: those of the 1918 class—these men having taken part in the last phase of the Great War, the class has been abnormally reduced by the casualties suffered; those of the 1919 class—these men were embodied by a process of selection before the termination of the war; and about two-thirds of the 1920 class, embodied in March last. Out of a total of 794,000 fully trained men, in the peace time army, some 330,000 should, in ordinary circumstances, have been demobilized during the first six months of this year; however, in view of the situation, the French Government decided to retain the 1918 class with the colours until June 15th of this year. Attention is called to the important discussions which have been taking place in the French Press on the subject of France's future army. The subject is also occupying the attention of the Chamber of Deputies; a Bill dealing with the re-organization of the Army was presented to the Chamber at its sitting of February 5th last, by certain members of the Socialist Party. Those who expected that the measure would contain revolutionary proposals are agreeably surprised at the moderation shown by the members of a Party which holds extreme views on army matters. It is proposed to retain conscription as the basis of recruitment for the French Army, but to limit the obligation for military service to 28 years in all.

Italy.—A special correspondent writes that Deputy Ivanoe Bonomi, who has taken over the Portfolio of the War Department from General Albricci, belongs to Bissolati's party and is a Socialist of the reformist group. A civilian has, it is stated, been appointed Minister for War in the hope that he will be able to take a strong line in reducing military establishments and, in consequence, the military budget. The new Minister has certainly been exceedingly active in promulgating measures affecting the Army since he took over the reins of office. He has reduced the establishment of Italy's peace time Army from 225,000 men to 175,000; corresponding reductions have been effected in the establishments of officers, horses, etc. The number of army corps is now 10 in place of 12—each of three divisions, total 27 Infantry Divisions and three Alpine Divisions. On the other hand, he has created a new Air Force.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

April–May, 1920.

APPARATUS FOR SEARCHING FOR UNEXPLODED PROJECTILES AND OTHER BURIED METALLIC OBJECTS.

La Vie Technique et Industrielle, in its number for February, 1920, referring to the importance of searching for buried projectiles, so as to render possible the cultivation of the battlefields, relates that in 1914 Professor Gutton, of the Faculty of Science of Nancy, together with M. Thiry, of the School of Agriculture Mathieu de Dombasle, had

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invented an electrical apparatus, based on the principle of the balance of induction of Hughes, to discover unexploded projectiles buried in the earth at a certain depth of the soil. Now, Engineer Chanoit, on the same principle, has constructed a more practical apparatus, and one more easily employed and requiring the work of only one operator while that of Gutton required two. This apparatus, which is attached to a telephone, is so regulated that when placed on the ground where projectiles are supposed to lie buried it reveals the presence of a metallic body. The apparatus can be carried on the shoulder by a strap. It can reveal the presence of a metallic object of 10 kg. weight at a depth of ·40 to ·50 m. and its action can be felt at a radius of about 1·50 m. The sensibility of the apparatus is such as to signal the presence of a copper disc of ·30 m. diameter and 1 mm. in thickness buried at a depth of about ·60 metre. This gives a means of determining with marked approximation (about 5 cm.) the point where the object is situated. According to the editor of the *Vie Technique* the apparatus Alpha is easily regulated and maintained, and would be of great service in searching for buried projectiles. Up to the present time the use of the apparatus is stated to be limited in France to the search for metallic objects, water and gas pipes, etc., and the results are favourable.

Latterly at Châtillon-sur-Seine, in the presence of the engineers of the Compagnie Générale des Eaux, small keys which had been lost and buried in the ground for about fifteen years were discovered in a few minutes. It was verified on this occasion that five minutes were sufficient to explore 50 square metres of ground.

E. T. THACKERAY.

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CURIOSA MATHEMATICA.

No. 1.

SOLUTION.

THE following numbers are written by the use of no numeral other than 2 (not even 0).

$$69 = \frac{\lfloor(2^2)}{\frac{C_2}{2^2}} \qquad 91 = \int_{\frac{2}{2}+2}^{\frac{2}{2}} 2x\,dx \qquad 93 = \int_{\sqrt{\frac{2}{2}}}^{\left[\frac{\lfloor(2^2)}{2}+2\right]} x\,dx$$

$$133 = \frac{2}{2}\frac{2}{2}\frac{2}{2} + 22, \text{ but not using } 222 = \int_2^{\sqrt{\int_{\sqrt{\frac{2}{2}}}^{\frac{\sqrt{\frac{2}{2}}}{\sqrt{2}}} x\,dx}} x\,dx \quad !!!!$$

$$137 = \frac{\lfloor(2^2)}{\frac{C_2}{2}} - \frac{2}{2} \text{ or } \int_{\sqrt{\frac{2}{2}}}^{\frac{\lfloor(2^2)}{\sqrt{2}}} x\,dx - 2$$

$$147 = \int_{\sqrt{\frac{2\times 2}{\cdot 2}}}^{22} \frac{x\,dx}{C_2} \qquad 149 = \int_{\sqrt{2}}^{\sqrt{\frac{\lfloor(2^2)}{2\times(\cdot 2)^2}}} x\,dx \qquad 483 = \frac{\lfloor(2^2)}{\frac{C}{2^2}}{22}$$

C. R. SATTERTHWAITE.

No. 2.

Proposed by Major Sir M. A. Cameron, K.C.M.G.

(Propounded by Dr. J. B. Emmerson of Biggleswade, in the *Spectator* of 31st December, 1901).

Write every number from 1 to 100 inclusive, using 4 fours, neither more nor less, the use of any digit other than 4 is forbidden; any recognized mathematical symbol may be used.

Examples— $\frac{4+4}{4+4} = 1$ $\frac{4\times 4}{4+4} = 2.$

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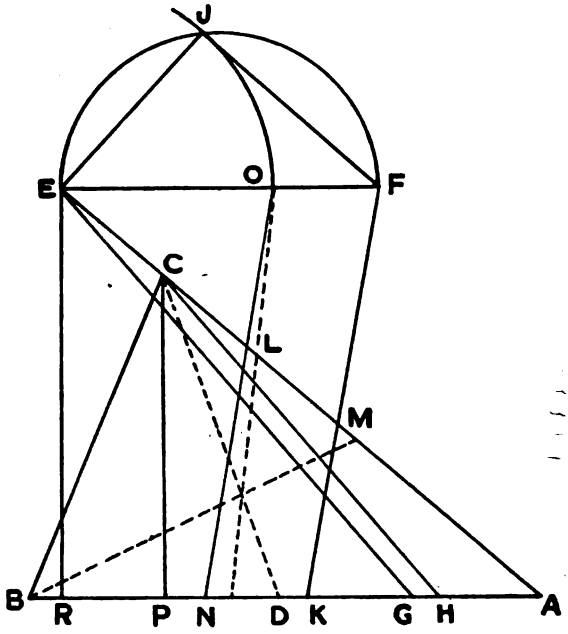
PROBLEMS.

PROBLEM 11 (Solution by XYZ).

To bisect a triangle by a line drawn from any point, O, within or without it.



Bisect, in D, that side on which a line from O, through the centre of the triangle, falls.

Call the opposite angle C. Mark, by A, that angle which lies on the same side of CD as O, and the third angle by B.

Draw EOF parallel to BA, cutting AC, or AC produced, in E.

Bisect DA in G. Draw CH parallel to EG.

Lay off, in the direction BA, OF = HA.

Describe a semicircle on EF. Make EJ = EO, and AK = FJ.

Then a line through O parallel to FK will bisect the triangle ABC.

Draw CP and ER $\perp^r$ to BA.

Since EO = EJ and AK = FJ, and since $\triangle$'s EMF, EOL, AMK are similar

$$\triangle EMF = \triangle EOL + \triangle AKM \text{ (Euclid VI. 31)}$$

$$\therefore \quad \text{trapezium } FL = \triangle AKM.$$

Consequently $\quad \|^m NF = \triangle ANL.$

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Now by similar $\triangle$'s

$$ER : CP = EC : CA = GA : HA.$$

$$\therefore \quad ER \cdot HA = CP \cdot GA.$$

Now $HA = OF$ by construction $= NK$,

and $GA = \frac{1}{2} AD$ by construction $= \frac{AB}{4}$.

$$\therefore \quad ER \cdot NK = CP \times \frac{AB}{4}.$$

That is $\|^{m} NF = \frac{1}{2} \triangle ABC.$

$$\therefore \quad \triangle ANL = \frac{1}{2} \triangle ABC.$$

PROBLEM 12 (SOLUTION).

Find the remainder 47^{7385} when divided by 17.

By Fermat's theorem $a^{m-1} - 1$ is divisible by (m) if (m) is a prime and (a) be prime to (m).

$$\therefore \quad 47^{16} = 17 \times \text{some factor} + 1 = 17a \text{ say} + 1$$

$$7385 = 461 \times 16 + 9.$$

$$\therefore \quad 47^{7385} = 47^{461 \times 16} \times 47^{9} = 47^{9} \times (17a + 1)^{461}$$

$$= 47^{9} (1 + 17 \times \text{some factor}) = 47^{9} + 17b.$$

Hence problem is reduced to finding remainder of 47^9 when divided by 17.

$$47^{9} = (2 \times 17 + 13)^{9} = 13^{9} + 17c$$

$$13^{3} = (129 \times 17 + 4).$$

$$\therefore \quad 13^{9} = 4^{3} + 17d$$

$$4^{3} = 64 = 3 \times 17 + 13.$$

Hence 13 is the remainder.

PROBLEM 13 (Major Satterthwaite, O.B.E.).

Is it possible to construct a triangle other than an isosceles triangle such that (i) All the sides are rational, and (ii) The perpendiculars from each vertex on the opposite sides are also rational?

PROBLEM 14 (Colonel C. L. Young).

Each player plays once with and twice against each other player; devise an arrangement satisfying these conditions. How many such arrangements are there?

J. M. WADE, *Lt.-Col.*

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PROFESSIONAL NOTES.

BRIDGING.

The re-design of the pontoon equipment has now been under consideration for some time and many officers in the Corps are anxious to know what progress has been made in this direction; the following notes may therefore be of interest.

The equipment must be capable of being built up into various forms to take the different loads, and the first step was to decide what loads should be carried by the equipment. It was agreed to be essential to retain the lightest and most rapid type of bridging equipment which would enable the fighting troops to cross a river; this load would include all field guns, horse-drawn transport, and infantry in fours; in fact the new equipment in its lightest form should carry the same loads as the old medium bridge with the existing pontoons. It was not considered necessary to design the equipment so that half pontoon (*i.e.*, the old light bridge) could be used.

In the next form it was thought that the equipment should be capable of being built into a bridge which would carry all the troops and transport of the Field Army with the exception of siege artillery and tanks. The heaviest load in this connection is the commercial lorry which has an 8-ton axle load.

In the heaviest form the equipment should be capable of being formed into a bridge which would carry all siege artillery and tractors, and the lighter forms of tanks (the latest tanks are comparatively light).

These loads have now been classified as light, medium, and heavy loads. In addition there are three other load classifications (see table). Bridges are required to carry a load of infantry in file for forcing a passage across a river. Then in mountainous country the heaviest load is often pack transport and bridges are only required to carry this load. Lastly there are the heavy tanks which weigh up to 35 tons and form a class by themselves. It was not thought necessary to take these special loads into account when designing the pontoon equipment. It was further decided that the bridge must be able to carry the medium loads crowded at a check, but that in the case

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of the heavy loads, the traffic could if necessary be regulated, so as to reduce the total load on the bridge.

When considering the loads brought on to a bridge by various orms of traffic there are three points to consider :—

(*a*) To determine the maximum concentrated load which the traffic will bring on to the bridge at any one point. This is usually the maximum axle load.

(*b*) This load is the greatest load which the bridge will have to carry up to a certain span which depends on the spacing of the wheels, etc. For instance if a bridge or span is 20ft. long the greatest load which can be brought on to this span by lorries is a concentrated load equal to the weight on the back axle of the lorry. On spans greater than 20ft. the greatest load would depend on the weight on the front axle of the lorry. Hence the second point is to determine up to what span does the axle load remain the maximum load

(*c*) Lastly, as the span increases the traffic may take the form of a distributed load more than a concentrated load and the stress in the bridge is proportionately reduced. Hence we must determine the equivalent uniformly distributed dead load for different spans produced by the various forms of traffic. Beyond a certain span the load settles down to the equivalent of so much dead load per foot run.

This information is contained in a concise form in the table.

For the bridge in the lightest form there is little doubt that the existing superstructure is very satisfactory and the problem is to design the best form of bridge to carry medium and heavy loads. Major Inglis suggested that a bridge for carrying either medium or heavy loads could be constructed by using a continuous steel girder over the pontoons as shown in *Fig* 1. As a heavy concentrated

FIG. 1.

load passes over the bridge the girder deflects but at the same time distributes the weight over several pontoons ; this avoids the necessity of making each pontoon or pier of pontoons capable of carrying the heaviest concentrated load. In the bridge as designed by Major Inglis, the weight is distributed by two lattice work girders some 3ft. 6ins. high, and the roadway is placed on the top of these girders. Sufficient pontoons would be used to enable medium loads to be crowded on the bridge but the traffic would be controlled with

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heavy loads. The advantages with this system of continuous girder are:

(i) The pontoons can be spaced as desired under the girders and damaged pontoons can be removed without disturbing the bridge.

(ii) The bridge provides a comparatively rigid roadway and the switch-back effect of the ordinary pontoon bridge is avoided.

(iii) The continuous girder work enables a clear span of 60ft. to be spanned for the approaches and so avoids the necessity of trestle work.

(iv) By regulating the traffic with heavy loads a saving of 50% in pontoons can be effected in the heavy bridge.

The disadvantages are:

(i) It is very difficult to devise a method of forming cut with this bridge.

(ii) An arrangement whereby the ramp can slide at the shore end has to be incorporated so as to allow for the rise and fall of tide.

(iii) The bridge is rather heavy and would be perhaps a trifle slow in erection for medium loads.

Some 200ft. run of girder work is to be constructed for preliminary trials with this system.

In the meantime designs are being prepared and experiments carried out for a pontoon equipment which shall carry the medium and heavy loads in a manner which is somewhat similar to the Bridges B and C in the S.M.E. Circular No. 25A. Further work in this direction will be described when more progress has been made.

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TABLE A.

The following Troops and Vehicles come under this Load Classification in their present Form, and can be crowded at a check.

Class of Load.	Maximum Axle.	Equivalent Uniformly Distributed Dead Load (For single line traffic).				
Infantry in single file.	—	$1\frac{1}{4}$ cwts. per ft. run. *				Infantry in single file. * For a fighting bridge a lower distributed load can be allowed.
Pack Transport.	—	$2\frac{1}{2}$ cwts. per ft. run.				Infantry in file. Cavalry in single file. Pack mules. Camels.
Light Loads.	2	6 tons for all spans up to 15ft.	7 tons for spans between 15ft. and 24ft.	8 tons for spans between 24ft. and 32ft.	5 cwts. per ft. run for spans over 32ft.	Infantry in fours. Cavalry in file. G.S. wagons, field guns, howitzers, motor cars and ambulances.
Medium Loads.	8	24 tons for all spans up to 20ft.	27 tons for spans between 20ft. and 30ft.	30 tons for spans between 30ft. and 50ft.	6 tons per ft. run for spans over 50ft.	6in. howitzer and limber. 60pr. gun and limber. All types of motor lorries and omnibuses.
Heavy Loads.	16	48 tons for all spans up to 30ft.	50 tons for spans between 30ft. and 50ft.	—	1 ton per ft. run for spans over 50ft.	Heavy artillery. All types of tractors, and the lighter varieties of tanks.
Tank Loads.	35	105 tons for all spans up to 105ft.	—	—	1 ton per ft. run for spans over 105ft.	An unrestricted stream of traffic except that heavy tanks must maintain a clear distance apart of 75 ft.

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THE RÔLE OF THE ROYAL ENGINEERS IN MECHANICAL WARFARE.

By Bt. Major G. Le Q. Martel, d.s.o., m.c., R.E.

During the war the Tank Corps grew from three companies to over thirty battalions, and this increase in fighting strength brought with it a great demand for assistance in various ways from the other branches of the service. For instance, the Tank Corps asked for and received special information and protection from the Air Force, and from the Royal Artillery special measures were required against anti-tank guns. The assistance rendered by the Royal Engineers to the Tank Corps was very varied, but was not fully developed during the war. If a similar war occurs in the future the Tank Corps will play a much greater part, and we must therefore have our ideas quite clear as to our rôle so that we may give the maximum assistance to this form of mechanical warfare. It was with that idea n view that this paper was written.

The Tank Corps in France was constantly faced with the necessity and difficulty of providing specialist tanks to perform various duties. Wire-pulling Tanks, Cable-burying Tanks, Bridge-laying Tanks, Sacrificial Tanks, and Mortar Tanks were all tried or suggested at various times. The main difficulty about the introduction of these specialist tanks was that fighting tanks had usually to be withdrawn from battalions and the crews trained at short notice in these special duties. If we consider the organization of the other arms of the service, we see that the fighting troops are relieved of specialist duties, such as the passage of obstacles or rivers, and demolition work, by the Royal Engineers. If therefore we can devise a universal type of R.E. Tank to carry out most of these requirements of the Tank Corps, we shall save withdrawing fighting tanks and crews for this purpose, and at the same time reduce the number of types of specialist tanks considerably. Trained sappers could adapt themselves to these varying duties far more easily than the crews of fighting tanks, and a higher state of efficiency would be obtained.

Many of these requirements deal with the passage of obstacles. Let us therefore now consider the question of the passage of tanks across tank obstacles under fire (when not under fire this work presents little difficulty, and can either be carried out by the Tank

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Corps themselves, or with the assistance of any R.E. unit). There are at present three classes of tank obstacles :—

(*a*) Gaps which may take the form of deep ditches or water obstacles, and which have at present to be bridged to enable tanks to pass.
(*b*) Barricades which have to be blown down with explosives to enable tanks to pass.
(*c*) Minefields which must be exploded or removed before tanks can pass.

Each of these three types of tank obstacle can be effectively dealt with by using one type of R.E. Tank such as is shown in *Photo* I. A Janney pump is fixed inside the tank and driven off the engine ; this supplies oil under pressure which works the hydraulic ram A above the tank. This ram pulls directly on the lever B which in turn actuates the jib C. The lever and jib are strong steel frames, triangular in shape, and are pivoted on the front of the tank.

As regards obstacle (a) this tank can be used for transporting and laying the 20-ft. tank bridge. The bridge consists of two steel girders, 26-ft. long ; the bridge can be laid in less than a minute and this is carried out from inside the tank ; in this way no one is exposed to fire and the bridge can therefore be laid under rifle or machine-gun fire. The bridge was originally designed to enable tanks to cross canals at the locks, but any small stream or gap up to 20ft. can be spanned in this way. The tanks cross on the two steel girders, but the bridge can be decked later to take wheeled vehicles. *Photo* IV. shows the tank carrying the 20-ft. Tank Bridge across country. *Photo* V. shows the bridge being laid across a gap of 20 ft., and VI. shows the tank crossing the bridge. For gaps which are wider than 20 ft., the R.E. Tank can often be used to assist in launching single span bridges. In some cases it is possible to launch the complete bridge and to arrange that the whole of the work shall be carried out from inside the tank, so that the bridge can be launched under fire. *Photo* VII. shows an Inglis Rect. Mark II. bridge being pushed across country by a R.E. Tank. The bridge is mounted on idle tracks and can travel at about 1 mile an hour. On arriving at the gap or river the bridge is pushed across until the idle tracks fall over the edge of the near bank. The R.E. Tank then draws back, which releases the hook on the jib, and any fighting tanks can now cross the gap. The first tank can be across the gap within three minutes after the time that the bridge arrives at the river. *Photo* VIII. shows the bridge in position ; the idle tracks have fallen over the edge of the gap and the R.E. Tank has drawn back to release the hook ; a fighting tank is about to cross the bridge. Gaps up to 70 ft. can be bridged in this manner. *Photo* IX. shows the details of the hook and arrangements for pushing the bridge. The Light Inglis

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Bridge can also be launched under fire by means of this tank. As the bridge is so light it can be pushed across country at 3 or 4 miles an hour and launched across a gap without any appreciable pause. In this way a passage can be forced by infantry across any river or gap up to 90 ft. If the ground was very firm and level a gap of 110-ft. could probably be spanned in this manner.

As regards obstacle (*b*) this tank can be used for laying and exploding demolition charges under fire. *Photo* XI. shows a boom fixed to the jib and a charge suspended from this boom. There are many occasions in war when a device of this nature would be of great value. In street fighting a strong house which could not be crushed by a tank could easily be blown down by using this method.

In a retreat if a charge on a bridge failed to explode, and the enemy gained possession of the bridge, a tank could sometimes return and lay a fresh charge and so demolish the bridge. The charge can be fired in several different ways. The tank can advance and lay the charge, light a time fuse and retire ; or if desired the tank can withdraw a few yards with wires leading back from the charge which can be fired electrically. With any charges containing up to about 100 lbs. of explosive the tank can advance and hold the charge in position and detonate the explosive without fear of damage to the tank.

As regards obstacle (*c*) this R.E. Tank can be used for pushing a steel roller for mine-sweeping, as shown in *Photo* X. The enemy were using small contact mines as an anti-tank defence towards the end of the war, and some type of small contact mine is likely to be extensively used in the future. By means of this roller a passage can be swept in such a mine field, and fighting tanks can then pass through this passage. The rollers explode the mines and are blown one or two feet into the air, but are not damaged by the explosive, nor is the tank affected when any of these small contact mines are exploded in this manner.

In addition to the requirements of the Tank Corps this tank can be used in many ways to assist in the normal R.E. duties in the Field. For instance, the tank can be used as a very powerful mobile crane. *Photo* II. shows the tank lifting the rear wheels of a 14-ton tractor which is ditched and replacing them on the road. *Photo* III. shows the tank carrying a bundle of girders weighing about 8 tons. The jib can be raised or lowered through an angle of 65°; in the lowest position the end of the jib is 2 ft. 6 ins. from the ground, and in the highest position it is 16 ft. from the ground. Loads up to 10 tons can be raised through this distance in 2 minutes. Over 10 tons the loads must be raised more slowly so as not to overload the hydraulic pump. The maximum load that can be raised is 15 tons. For clearing roads of débris such as broken bridges, this tank would be invaluable in war. It is also probable that this tank will be required

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to act as a tractor for excavating and cable-burying devices. It may further be possible to adapt the jib for use as a mechanical shovel.

We have now seen that the tank can be used in a multitude of ways to assist the Royal Engineers both as regards their ordinary work and with respect to the R.E. requirements of the Tank Corps, and we can now suggest what further steps should be taken. There are two ways in which the Tank Corps may expand. The Corps may either grow up as an adjunct to the Army, and this is the present position of the Tank Corps, or tanks may be gradually incorporated into battalions and artillery units in much the same way as the old rifleman was incorporated and gradually ousted the pikeman from the infantry units. In the event of the Tank Corps remaining a separate body the Royal Engineers should form mechanical Field Companies to carry out their requirements in the same way as Field squadrons carry out this work for the Cavalry. These mechanical companies should be self-contained units ; they should be organized in four sections, each section having four tanks. The tanks would carry much the same tools and explosives as a Section of a Field Company. If the Tank Corps becomes incorporated with the remainder of the Army then the right policy would appear to be to introduce tanks gradually into the Field Companies. At first one section in the Field Company would be converted into a section of a mechanical Field Company and given four tanks, and later, as mechanical warfare progressed a greater proportion of the company could be mechanicalized. As the tanks become faster and increase their radius of action, they will carry out raids on the enemy's communications. In this duty they will require considerable assistance from the Royal Engineers in demolition work, etc. Sappers will therefore have to accompany these raiding tanks and will be required to be mounted on fast tanks ; in fact this will be one of the main duties of these suggested mechanical R.E. Units.

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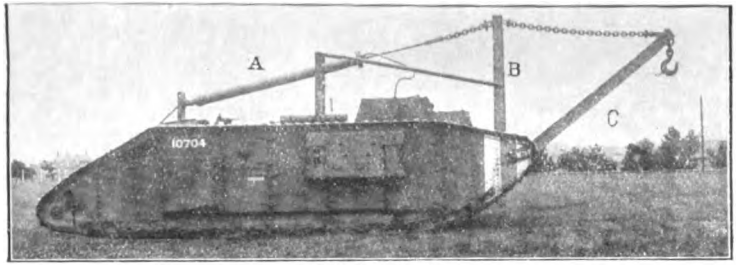
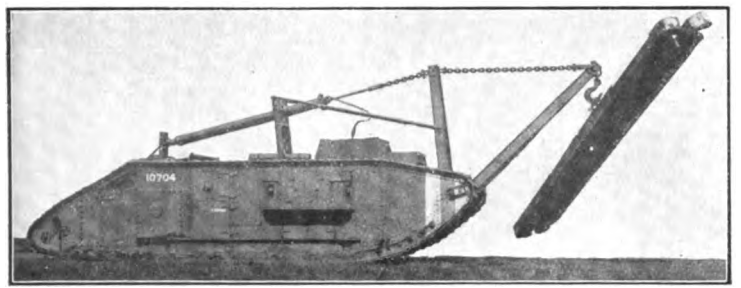
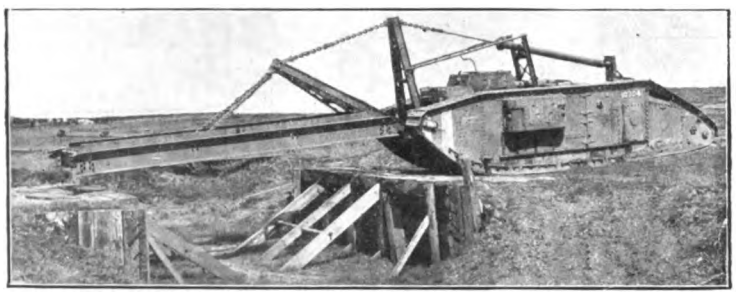


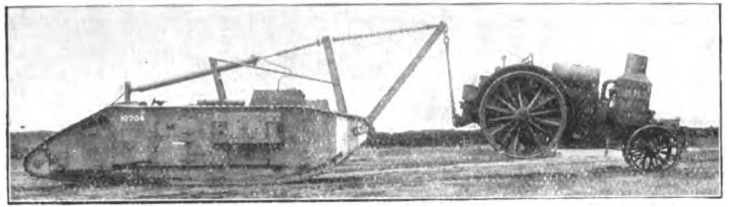
1. The R.E. Tank.



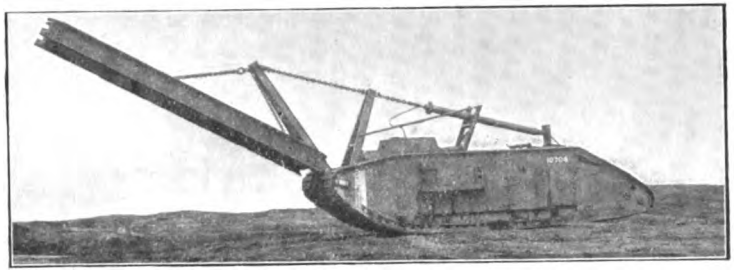
3. The R.E. Tank carrying girders weighing 8 tons.



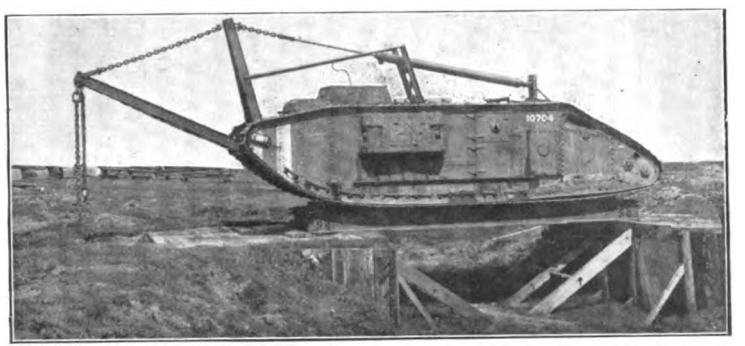
5. The bridge being laid across a gap.



2. The Tank lifting the rear wheels of a 14 ton tractor which was ditched.



4. The 20-ft. tank bridge in the carrying position.



6. The tank crossing after laying the bridge.

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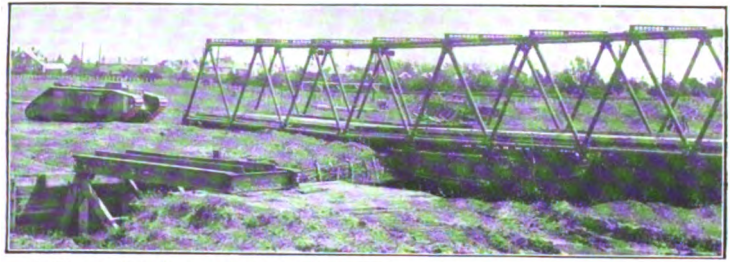
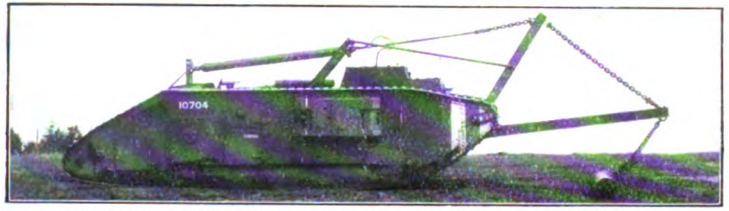
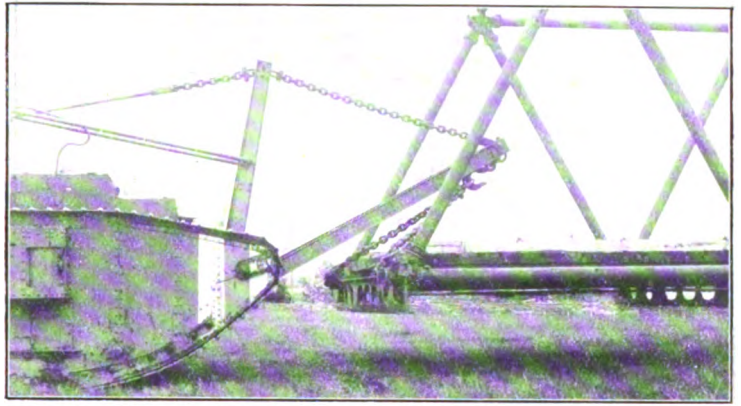
7. The R.E. Tank pushing a heavy tubular bridge across country. The bridge is mounted on the idle tracks.



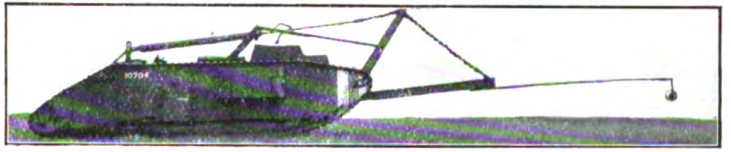
8. The bridge in position across a gap of 70 ft. The idle tracks have just fallen over the edge of the near bank.



10. The R.E. Tank fitted with a mine sweeping roller for clearing a passage through an anti-tank mine field



9. The details of the arrangement for pushing the bridge.



11. The R.E. Tank fitted with a bowsprit with a charge at the end for carrying out demolition work under fire.

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SANITARY CONGRESS, BIRMINGHAM.

By MAJOR-GENERAL E. H. HEMMING, C.M.G., F.R.S.I.

THE thirty-first Congress and Exhibition of the Royal Sanitary Institute was held at Birmingham, July 19th to 24th, 1920. For the benefit of those who have possibly never attended a sanitary congress of this kind, I may say that, apart from the necessary inaugural meetings, addresses, and receptions, the programme usually consists of daily and simultaneous meet ngs of the respective sections which deal with the ever-varying and far-reaching subject of sanitation as applied to the different branches and professions of science and administration. At these meetings, papers on subjects of contemporary interest are read and discussions are invited, under the Chairmanship of eminent authorities of the particular branch with which the section deals. The afternoons are spent in visits to engineering and other works illustrating the application of modern sanitary science, and the evenings are devoted to popular lectures and re-unions. Throughout the Congress a Health Exhibition is held under the auspices of the Institute, and many of the newest and best inventions connected with applied sanitation are shown. I was very glad to take advantage of the invitation of the R.E. Institute Council to attend this Congress in the interests of the Corps and in my own interests, both in my connection of many years with the Royal Sanitary Institute, and in my immediate connection with "Housing" under the Ministry of Health.

Although there are in such a Congress as this a great many subjects and opportunities which are of special interest to the sanitary expert and also of common interest to the public as intelligent citizens, and co-operators in the world-wide work of sanitation, I do not propose to attempt to cover more ground in this report than will, I hope, appeal directly to the Corps.

The Presidential Address by Viscount Astor, and the Public Lectures on "Mind and Body" by Sir Frederick Mott, and on "Links with the Tropics" by Dr. Andrew Balfour, were extremely good hearing but hardly sufficiently technical for any detailed reference in the *R.E. Journal*.

Of the various sectional Meetings I give below an extract of those that may interest the R.E.

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ENGINEERS AND SURVEYORS.

Address by the President; Sir H. P. Maybury, K.C.M.G., C.B., M.INST.C.E.

1. "The Hygiene of Road Pavements," by Ernest Worrall, F.S.I., Engineer to the Stretford U.D.C.
2. "Arterial Roads and Road Classification," by C. F. Gettings, M. INST. C.E., County Surveyor, Worcestershire.
3. "The Evolution of the Road," by J. Willis-Bund, C.B.E., LL.B., Chairman Worcestershire County Council.
4. "The Local Surveyor," by F. G. Fisher, Superintending Valuer, Central East Division, Inland Revenue, Birmingham.
5. "The Conservation of Water Supply in England and Wales," by F. W. Macauley, M.INST.C.E., Birmingham.

ENGINEERING AND ARCHITECTURE.

Address by the President, W. E. Riley, F.R.I.B.A., M.INST.C.E.

1. "Reconstruction of Slum Areas," to be opened by Lieut.-Col. W. J. Travers, O.B.E., F.R.I.B.A.
2. "The Case for Higher Buildings," by Delissa Joseph, F.R.I.B.A.
3. "The Renovation and Re-modelling of Cottages in Country Districts," by Miss A. Churton, Secretary, Rural Housing and Sanitation Association.
4. "The De-watering of Sewage Sludge, with special reference to the Birmingham Method," by F. R. O'Shaughnessy, A.R.C.SC., F.I.C.
5. "Notes on Domestic Drainage," by J. Stuart King, A.M.I.C.E., M.I.M. & C.E. (Birmingham).

Most, if not all, of these papers and discussions are printed and published in due course in the *Journal of the Royal Sanitary Institute*, and if any sapper would like to have copies of any special papers, I will do my best to obtain them.

The visits to public works and institutions included inspections of the Frankley Water Works, the Sewage Farm, the Garden Village of Bournville, the Electric Generating Station, Destructor Works, and the Sanatorium for Tuberculosis. Of these, the Garden Village of Bournville was particularly interesting from the Housing point of view—some of the public buildings in the village are also architecturally noteworthy. The other works mentioned above would also be of interest to the Corps generally, but are, for the most part on a larger scale than would usually come within the scope of R.E. work.

The Exhibition was unique of its kind, being thoroughly representative of really up-to-date sanitary science and of modern labour-saving appliances and refinement of living. There was a noticeable

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absence of the more ordinary sanitary fittings in common domestic use which evidences the fact that the general public, thanks in no small degree to the energies of the Royal Sanitary Institute, no longer need to be reminded of the fundamental elements of sanitation in connection with the disposal of waste products, and excreta.

The needs of the small house where economy, cleanliness, and self-contained labour-saving apparatus have become essential, were well catered for, such as, for instance, gas and other cookers or ranges, combining sitting-room and kitchen fires with heating and hot water supply, combination kitchen dressers and furniture, electric sweepers, modern baths of moderate size, steam-consuming coppers, disinfecting sprays, etc.

Models of some of the housing schemes were also shown with communal hot water supply, heating and laundry work. These are particularly worthy of note to the Officers of Engineers who are employed on building works and are specially concerned with the housing of married soldiers, which must keep pace, both in fittings as well as in design and grouping, with the present advances in the housing of the working classes.

Of general engineering interest to the sapper, the exhibition included among other devices, a pipe-bending machine, an extracting cowl, drain plugs, reversible and folding casements, a device for repairing slate roofs, labour-saving wall plugs, electric floor-planing machine, concrete water-proofing materials, etc.

I have selected a few of the exhibits which I think are worthy of special attention :—

Stimex combined gas fire and range is economical in practice and avoids the use of naked burners in the oven. This is rather an expensive fitting. (J. J. Chettle & Co., 185, King's Cross Road, W.C.)

Electric Suction Sweepers.—Of the various Electric Suction Sweepers, the Hoover and the Canadian are the best examples of these articles and represent a high and a comparatively low priced article. These are of general interest and constitute one of the greatest advances in domestic hygiene, and are worthy of consideration in connection with the hygiene of Military Barracks as a substitute for the still prevailing and primitive methods in use for spoiling floors by swilling them with water. (The Hoover Suction Sweeper Co., 288, Regent Street, W. and Napier Kimber Ltd., 109, Great Portland Street, W.)

Esavian Windows and Screens.—By this patent, long lines of casement windows are made to fold to one or both ends, leaving an unbroken opening. Useful for sanatoria and open-air schools ; any pair of casements can be folded separately where a smaller opening is required ; the casements are quite weather-tight when closed. The same principle is applied to folding screens and shutters which

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can be used in lieu of sliding doors. These were used for Aeroplane Hangars during the war. (Educational Supply Association Ltd., 40–44, Holborn Viaduct, E C.)

Rawlplugs are a special form of wall plug consisting of a fibre tube made in various sizes and lengths to suit different sizes of screws; the hole is jumped by a special tool corresponding to the plug. They are extremely neat and strong and very rapidly put in, and constitute a great advance in every way on the old fashioned wall plug for all kinds of fittings, electric switches, etc., etc.; stronger and quicker and do not spoil the wall; can be fixed equally easily in tiles, bricks or plaster. (Rawl Plug Co., Ltd., Lenthall Place, Gloucester Road, S.W.)

Blackwell's Bitumen Roofing Felt and pure Bitumen dampcourse, are good and not expensive. (R. W. Blackwell & Co., Ltd., 36, Emperor's Gate, S.W.)

The Simplex Floor Planing and Treatment System, consists of an electrically-driven planer from an ordinary lighting current, followed by a sand-papering machine. The rest of the treatment which is optional, consists of filling and waxing. This method effects a great economy of time and labour in the planing of old and new floors, on a large scale, and would form a valuable adjunct to R.E. shops in a large military station or district. (J. & M. Steingold, 23, City Road, E.C.)

The Activated Sludge Process.—This is a substitute for the ordinary biological installation of septic tank and filter; existing tanks can be converted. This system involves practically no loss of fall, is compact, and cleanly, and said to be free from smell, leaving a pure effluent and a valuable sludge. It is especially applicable where power is available. The principle is roughly as follows:—After a preliminary screening, the sewage is agitated and aerated by forcing air through diffuser plates in the bottom of the aerating tank. After a certain time, the sewage passes into a settlement tank, thence the sludge passes to sludge beds for drying, and the clear effluent remaining is discharged to a suitable outfall A fuller description will be found in the revised War Office Drainage Manual. (Activated Sludge Ltd., 14, Howick Place, Westminster, S.W.)

The Foresight Combination Range.—Consists of a range and oven with back boiler worked from an open fire. It is an effective and useful pattern where cooking is done in the living room. (S. Smith & Sons, Beehive Foundry, Smethwick).

The Japkap Water Waste Preventer is one of the best. It is very quiet and effective, the novelty of the principle being that the water rises through a flap valve in the plunger, which fits the cyclinder exactly, instead of through an annular space around a loose-fitting plunger. The flush will act with a small quantity of water and cannot act continuously. (Claughton Bros., Ltd., Bramley, Leeds).

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Scols Pipe-Bending Machine, Extract Ventilator Cowls, Iron and Steel Cements, etc.—These are all worthy of note. The Scols pipe-bending machine is very portable and suitable for use on site of works, eliminating delays and cost of obtaining special bends, makes a great variety of cold bends in various sizes of pipes, would be a useful adjunct to any shop catering for water and gas work and repairs The extract cowl of "Visor" pattern is very effective. The iron and steel cement, elastic cement, etc., are also recommended for foundry use and for repairs. (Thomas Ash & Co., Berkley Street, Birmingham).

Owen Patent Hot Water Tank.—This is an ingenious arrangement in which the ballcock supply is fixed inside the hot water tank or cylinder. It is suitable for cottages and married quarters, and is very economical in piping, and probably has a slightly greater heating efficiency than the ordinary system owing to the water in the supply pipe being warm when it enters the boiler. (Rowe Bros. & Co., Ltd., Berkley Street, Birmingham).

Wifesjoie Cooker.—This is a one-ring gas cooker, with special boiler for hot water circulation and baffle in oven to keep the flame from the meat, etc. It is very efficient and remarkably inexpensive. A great advance in economical gas ranges for small houses. (London Warming & Ventilating Co., Ltd., 20, Newman Street, W.)

Rigifix Bolt Hanger Sockets and Slotted Inserts.—This is extremely useful for fixing shafting, etc., in workshops, etc., of reinforced concrete construction. (Building Products, Ltd., 44, 46, King Road, Chelsea, S.W.)

Tenter Slate Clips, Tenter Casement Hinge, Tenter Drain-testing Plug.—The slate clips are rivetted to the slate to be inserted for a repair and the latter is pushed up under the slate above until the clips pass the batten, where it is firmly fixed and cannot be withdrawn, very ingenious and simple; a vast time saver in roof repairs and cost nominal. The hinge is most ingenious and makes it possible to hang a casement sash from either side at will—according to which-ever way the wind is blowing; can be used for hoppers in the same way and solves the cleaning difficulty—a very ingenious invention. The drain plug is a combination of three sizes in one, very strong and simple and makes for portability. A square gully plug is made for use with the drain plug. (Sheffield Hardwares, Ltd., Tenter Street Works, Sheffield).

This list omits many interesting exhibits, but comprises the best of those that are of immediate interest to the officers of the Corps. Some of these may be already known to our officers but they are good enough to bear repetition.

There is one very special and important exhibit from the active service point of view which had been arranged for the War Office by the Professor of Hygiene at the R.A.M. College, consisting of a

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collection of models of sanitary apparatus and devices in connection with the Military Hygiene of the War. These included Latrines, Incinerators, Baths, Water Supply Arrangements, etc., etc. These models will be permanently housed in the R.A M. College Museum at Millbank, and will be well worth inspection by the Corps.

I met the Director of Hygiene at the Congress, and he informed me in answer to enquiries that a number of plates were to be published illustrating the best of these fittings. I was glad to hear also that a Joint Committee of Engineers and Medical Officers had been entrusted with the task of standardizing these fittings for use in various possible theatres of war.

I must apologize if I have failed to make my record very interesting reading. The Exhibition, however, in connection with this Congress is really something quite out of the run of the ordinary building trades' exhibition; indeed it is the object of the Royal Sanitary Institute to make these Exhibitions educative rather than commercial. And if my report will induce any Officers of the Corps to seek election as members of the Royal Sanitary Institute, or will help them to a livelier interest in sanitary matters in peace or war, or to the introduction of modern improvements and economies in the fittings and repairs of military buildings or in workshop equipment, it will not have been written in vain.

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THE 106th FIELD COMPANY, R.E., AT LE BIZET AND ROMARIN.

On the 9th April, 1918, the enemy attacked south of Armentières. The 25th Division had recently arrived in the Ploegsteert Area, after heavy fighting in the neighbourhood of Bapaume. Losses had been made good. The R.E., consisting of the 105th, 106th and 130th Field Companies, R.E., and the Pioneers, the 6th Battalion South Wales Borderers, together with the rest of the Division, were busily engaged in bringing up their fighting efficiency. Capt. E. P. D. Cator, R.E., had recently arrived as 2nd in command of the 106th Field Company and, Major Lynam being on leave, was commanding the company. On the 8th April Company Headquarters and one section were at Nieppe and the three forward sections at the Laundry, Venne. The company was employed on the Right Brigade Sector strengthening forward defences.

Narrative of Events, 9th–19th April, 1918.

Nieppe. 9. 4. 18.—Company H.Q. at Nieppe shelled by H.V. guns. Forward sections at work in line. Company H.Q. and No. 2 Section moved to Romarin Camp. Sections in line joined them at 5 p.m. Company placed under the orders of Lt.-Col. Fitzpatrick, D.S.O., 6th South Wales Borderers (Pioneers).

9 *p.m.*—The whole Company, inclusive of dismounted H.Q., batmen, etc., marched to Pont Nieppe and dug in on left bank of river Lys with the 6th S.W.B. on right, 130th Field Company on left, 105th Field Company in support.

10. 4. 18.—7 *a.m.*—Enemy reported to have pushed forward between Ploegsteert and Le Bizet. The Company was immediately ordered to Le Bizet and assembled for counter-attack under Lt.-Col. Fitzpatrick. Later, the Company held a line in rear of the village. The infantry were gradually forced back, and at noon the Field Companies' position became the front line.

1 *p.m.*—Conforming to withdrawal on their left the Company withdrew to a shallow trench and ditch line 200 yards in rear. This position was held for 4½ hours against repeated enemy attacks.

5.30 *p.m.*—Enemy reported to have turned left flank. Heavy enemy M.G. fire, enfilading Company from left, made position untenable. The Company, together with approximately 200 men of the Border Regiment, in order to avoid destruction or capture, withdrew

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in dark across the open under terrific M.G. fire and took up position in line with the Vanne-Romarin road, the right flank resting on bank of river Lys. Casualties—1 O.R. killed, 13 O.R. wounded.

11. 4. 18.—The Vanne-Romarin road position was held till 3 a.m., when the three Field Companies marched to Dou-Dou Farm and joined the S.W.B.'s, taking up a defensive position in front of this farm. This position was held against repeated enemy attacks.

6 *a.m.*—An enemy 2-seater plane firing on our positions whilst flying at very low altitude was fired upon and brought down, behind the line, by Lewis gun and rifle fire. It was immediately seized by units of 34th Division in rear. Another plane brought down by the Sappers fell in enemy lines.

8 *a.m.*—Enemy could be plainly seen in small parties on the Ploegsteert-Le Bizet road, apparently placing M.G.'s and laying telephone wires ; these parties were fired upon and casualties observed.

9 *a.m.*—Enemy attacked all along the front ; he was apparently easily held.

10 *a.m.*—Message received that our troops on the extreme right were withdrawing to Army line. Capt. E. P. D. Cator went at once to verify this message, and on return ordered the Company's withdrawal to Army line. The Company on its withdrawal was attacked by the enemy, who suddenly appeared close behind in large numbers. The enemy artillery placing a very heavy barrage over the area of withdrawal, which, in spite of its intensity, caused few casualties. At time of reaching Army line enemy were only 150 yards in rear, some of whom were wearing forage caps. They undoubtedly captured a few men suffering from wounds and fatigue. At time of reaching Army line it was found to be unoccupied. The Company took up positions in the line and immediately prepared for vigorous defence, opening up rapid fire on the enemy, who could now be seen less than 120 yards away firing from the standing position ; our fire had certainly the effect of checking his advance. We had only occupied this position for a few minutes when an order was passed from the right to the effect that the right flank was withdrawing. Verification of this message was asked for by officers of this Company as we were under the impression that this was our last line of trench ; before an answer could be received troops on our right and left could be seen to leave the Army line. The enemy by this time could be seen advancing on our flanks, firing as they came forward. It was now evident that we were in danger of being outflanked as we were apparently the only unit in the trench. The enemy in places managed to reach the wire and again opened rifle fire. Rapid fire was ordered to put the enemy out of action in order that we could withdraw, and this withdrawal was carried out by sectional rushes, the men passing through heavy hostile artillery barrage with very few casualties in this withdrawal. Some 500 yards to the rear

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we came upon units of the 34th Division holding a line of rifle pits. We immediately placed ourselves at the disposal of a Brigadier of this 34th Division, who ordered us to go in support of units of his brigade on the left flank, and re-take the Army line. Our men, though very much exhausted by the strenuous fighting during the past 40 hours, joined up in two waves, the first wave under Lieut. Saxon, R.E., and 2nd Lieut. Kennedy, R.E., the second wave in charge of 2nd Lieut. Rice, R.E. and 2nd Lieut. Turner, R.E., and in conjunction with the aforesaid unit took the village of Romarin, except the eastern edge, after four hours' attack, during which time the enemy relied very much upon his M.G.'s. (During this time we were without the Company Commander, Capt. Cator, who had left us whilst we were in the Army line in order to get in touch with people on our right flank; it was afterwards reported to us that he had been killed in front of Brune Gaye). In the advance upon the village of Romarin our left flank was held up by enemy M.G. fire, and the right flank of second wave, in order to avoid this fire, worked forward under cover of houses and ditches, and eventually reached the S.W.B.'s in the village. This position was held until dusk when the enemy opened heavy fire (artillery) on the village. A message was received that the right flank was withdrawing from the village. This message was verified by a R.E. officer and to conform to this movement our left flank also withdrew. The units had now become very scattered, and in the dusk an attempt was made to re-assemble the R.E.'s of the 105th, 106th and 130th Field Companies. On assembling the party numbered about 45 O.R. It was then decided to report for orders to Brigadier of the 34th Division, and the party made its way with difficulty to the main Armentières-Bailleul road, which we found being heavily shelled from both sides. The road was crowded with troops and transport moving towards Bailleul, and on enquiry we ascertained that the 34th Division was withdrawing towards Bailleul. The situation for us became very obscure, and in view of the fact that the men were with difficulty prevented from falling out from exhaustion it was decided to report at once to the C.R.E. of our Division. We arrived at St. Jans Capelle at midnight. Casualties—Capt. E. P. D. Cator killed; O.R., 3 wounded.

12. 4. 18.—Having reported to C.R.E. 25th Division, we were ordered to our Transport Lines, where men rested pending orders.

5 *p.m.*—The Company received orders to proceed and take up position on Asylum Hill, where it dug and occupied strong points, putting out wire entanglements with wire found near the position. Lieut. Ellen, R.E., was temporarily placed in charge 130th Field Company, and Capt. Musgrave, M.C., R.E., in charge 106th Field Company. Casualties—O.R., 2 wounded.

13. 4. 18.—The Company was ordered to proceed to a defensive position in front of Dranoutre, and dig in. The Company was in

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support to the 105th Field Company, on the left, and the 130th Field Company on the right.

14. 4 18.—The position was wired during the evening. 2nd Lieut. Kennedy, R.E., was temporarily transferred to 130th Field Company. Patrol work was carried out during the evening and night.

15. 4. 18.—Lieut. Saxon, R.E., was temporarily transferred to command the 105th Field Company, R.E. Position was shelled throughout the day. At about 3 p.m. hostile shelling of great intensity was observed along Ravelsberg Ridge about 800 yards in front of our position. At 3.30 p.m. British troops were observed coming over the ridge in small parties, apparently withdrawing. Lieut. Cooper, M.C., R.E., and 2nd Lieut. Rice, R.E., proceeded forwarded to ascertain situation. They found stragglers, who informed them that they had been forced back. The enemy were observed coming over the ridge in force ; they also saw a party of 12 soldiers in British uniforms being marched way as prisoners by the enemy. These two officers collected a party of these stragglers and pushed forward to the foot of the hill and opened out vigorous L.G. and rifle fire on the enemy, causing heavy casualties, and then sent back for reinforcements and ammunition. The enemy in the meantime moved to the right in large bodies offering a very favourable target to the three L.G.'s with this party. Reinforcements having arrived, the remainder of this party withdrew to a position behind the railway, 300 yards in rear. The R.E. officers having reported to an Infantry captain returned to take charge of their own units.

16. 4. 18.—Our position was heavily bombarded. Our line was now apparently the front line, the troops who had been holding the position in front of us having been withdrawn. Enemy attacked our position in the afternoon, but was beaten off by artillery and rifle fire. An enemy aeroplane was brought down by our L.G.'s rifle fire and fell 500 yards to our left front. The Company formed a fighting patrol, which brought back valuable information. Casualties—1 killed, 3 wounded.

17. 4. 18.—Position heavily shelled by hostile artillery of all calibres. Enemy attacked repeatedly and succeeded in gaining a footing in farm on our right flank ; we assisted the H.L.I. in ejecting him from this position. A few prisoners were brought back by the H.L.I. (one a N.C.O. wearing gray German uniform, with coloured tabs on collar and double eagle design on buttons of tunic ; he carried excellent contoured maps of the locality, a Véry Light pistol, and an automatic pistol) which were taken charge of by Major Chalmers, of the H.L.I. ; the Major being killed five minutes afterwards by an enemy shell, and we had no further opportunity of examining prisoners' equipment. Part of our front line became untenable, being blotted out by hostile artillery fire. Casualties—Lieut. Ellen, R.E., wounded ; O.R., 4 killed.

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18. 4. 18.—A quiet day after heavy early morning bombardment, snipers and M.G.'s alone were fairly active. Enemy frequently exposed himself in small numbers and many casualties were inflicted on him by our well-directed rifle fire. The companies were relieved between midnight, 18th–19th and 12.30 a.m. 19th. Casualties—1 O.R. killed, 1 wounded.

19. 4. 18.—Marched to Aragon Camp and rested, and proceeded later to Transport Lines behind Abeele.

The Company was unfortunate in losing the services of some excellent Officers and N.C.O.'s. Captain Cator was only in command for 8 days, but during that period had shewn himself possessed of great courage, energy, resolution and ability. His handling of the Company during operations was admirable. The splendid example of indomitable cheerfulness and complete personal disregard of danger shewn by Lieut. C. W. Ellen had an excellent effect on the men. Even when severely wounded he displayed the same characteristics. Sergt. H. J. Stevens (killed) and Sergt. A. Smith (died of wounds) shewed themselves worthy of the best traditions of the Corps.

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TWO GERMAN BOOKS ON FIELD FORTIFICATION

By BRIG.-GEN. J. E. EDMONDS, C.B., C.M.G.

DER PIONIERDIENST IM KRIEGE MIT EINEM ÜBERBLICK ÜBER DIE ENTWICKLUNG DES FESTUNGSBAUES AUF GRUND DER KRIEGSERFAHRUNGEN,

BEARBEITET VON MAJOR TOEPFFER.

(Berlin, Mittler 10 marks).

This is not a text book of field engineering but a summary of the various activities of the German *Pioniere* (Field Engineers) during the War, with a section on the development of permanent fortification. It leaves the impression that the author was directed to write a paper on the duties of engineers in the field, founded on the German text books and memoranda issued during 1917 and 1918, for inclusion in the next edition of Field Service Regulations, Part I. As such it is a convenient record of principles that do not differ from our own. It is divided into three parts :—Engineer duties, Means of Illumination and Signal Service, and Construction of fortresses. The short introduction is worth translation in full :—

" A knowledge of engineer duties and of the work of engineer troops " should be acquired by officers of all arms.

" Engineer officers must make proposals for the best employment of " their arm to further the intentions of the commander of their formation, " and assist the troops in their execution. A knowledge of the tactics " and duties of other arms is therefore indispensible.

" Engineer companies or platoons must be employed as units (not " frittered away in small parties) and supported by working parties from " other arms as necessary.

" The preparation and execution of engineer work demand time. It " is most important therefore that requirements should be recognized " early and reconnaissances carried out, and arrangements made for " bringing up men, stores and transport in good time.

" The work that will probably be wanted from the engineers must be " borne in mind in drafting orders of march and in quartering troops."

Part I on " Engineer duties " has sections on field fortification in open warfare, trench warfare, demolitions, mining, bridging, roads and tracks, and camps and bivouacs. There is little to remark in it ; in addition to the usual matter it contains sub-sections on inundations, protection from aerial bombs and defence against tanks. As regards the second, the book says:

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"Compared with artillery shell, aerial bombs strike perpendicularly, "and only the roof of a building is hit directly, although a bomb falling "near to a side may exert effect on the walls by explosive force or air "pressure. The roof must therefore be made specially thick and the "walls may be thin, though of course sufficiently strong to carry the "weight, if the roof overhangs . . . Definite data for the roof "thickness cannot be given as there are so many different kinds of "bombs."

Tank defence is divided into active defence by guns and trench mortars, and passive defence by obstacles, either natural ones improved, or minefields or craters (on roads). Under demolitions, there is a page on liquid air as an explosive. It is recommended as economical and suitable for blasting dugouts and tunnels, even in the hardest rock.

The third part on fortresses is of most interest. It commences with a good definition :—

"A modern fortress is a well prepared battle field, on which the defender must, as elsewhere, appear with considerable forces and the most up-to-date weapons." There is no fixed form; there must be the fullest use of ground and a proper tactical employment of guns and rifles.

To summarize the principal remarks :—In the first period of the war the value of fortresses was considerably under-estimated. After the fall of the Belgian and some of the French fortresses the rôle of permanent fortifications seemed played out; and this opinion was confirmed by the rapid surrender of the great Russian entrenched camps. After the fighting at Verdun judgment was revised; it was recognized that the Belgian fortresses and Maubeuge were far from up-to-date—long and short range guns, O.P.'s, searchlights and shelters were all crowded together in small forts offering splendid targets. The armour was inefficient even against the older types of howitzers, and the concrete was poor, too thin, and seldom reinforced. There were no precautions against the effect of blast and inadequate ventilation against gas. The tactical siting of the works was indifferent. The Russian fortresses were more or less out of date or not ready. They were for the most part evacuated on account of the strategic situation or of the lack of energy on the part of leaders and troops. The Italian barrier forts in the 12th Battle of the Isonzo failed because their armour and concrete were hardly sufficient, and there was no protection against gas.

On the other hand the Russians in 1914 and 1915 failed to capture the small fortress of Lötzen (in the Masurian lake district; it is the first we have heard of its action), and the small Austrian works on the South Tyrol front held out though bombarded with 12-inch howitzers for months. Verdun showed the value of permanent works when held in the battle line; they would have been easily captured if the fortress could have been surrounded.

There is no mention of camouflage in the book, and there are no illustrations.

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UNSERE PIONIERE IM WELTKRIEGE HERAUSGEGEBEN AUF VERANLASSUNG DER EHEMALIGEN GENERAL-INSPECTION DES INGENIEUR UND PIONIER-KORPS UND FESTUNGEN.

(Berlin Kyffhaüser, 25.90 marks).

This much advertised book, brought out under the official auspices of the last Inspector-General of the German Engineer and Pioneer Corps and Fortresses, General-Major Marschall von Bieberstein, is somewhat disappointing. It consists of some 40 short articles by different hands, written in very popular style without technical detail, describing incidents and work in which the *Pioniere* took part, *e.g.*, the passage of the Save, Before Verdun, War Underground, Bridge Demolition, German *Pioniere* in Palestine, At Mort Homme, *Pioniere* in Attack, Gas *Pioniere*, Ancre, The Death of Bapaume. We hear, however, for the first time it is believed, of "Landing Companies." In peace time a battalion stationed in Schleswig-Holstein made a special study of, and carried out experiments with the boats, piers and other apparatus required for landing on an enemy's coast, in conjunction with the Navy. The units so trained were used on the Danube and its tributaries.

The flame-thrower, it appears, was invented 12 years before the war.

General von Telle, Ludendorff's Engineer adviser, in a preface enumerates the various branches of *Pioniere* work. He gives particular praise to the Ingenieur-Kommittee, whose title, as it sounds foreign, he translates as meaning "Engineer Experiment and Supply Office." This organization, which had a staff of "40 officers in peace and several hundreds in war time," conducted, before and during the war, trials of inventions, etc., and arranged the supply of all engineer stores (which included signal gear and "weapons of close combat, grenades, trench mortars, etc."). He gives the following figures (apparently much lower than our own) as regards stores supplied:—13,000 electric light projectors, 10 million shovels, 1,500 train loads of cement, 600 million sandbags, 635,000 tons of barbed wire, nearly 5,000 dynamos, 80,000 Granatenwerfer, with 30 million rounds, 270 million hand grenades, 160 million firework signals.

There are 28 pages of excellent photographs depicting various engineer activities, mostly bridging: in this respect at any rate the Germans were evidently much behind us.

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Bt. Lieut.-Col. Gerald Brice Ferguson Smyth, D.S O.,
Royal Engineers.

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MEMOIR.

BREVET LIEUT.-COLONEL GERALD BRICE FERGUSON SMYTH, D.S.O., ROYAL ENGINEERS.

GERALD SMYTH was, I believe, one of the most distinguished Royal Engineer officers who served in the late war, through which he survived, only to meet his death at the hands of dastardly assassins in the Cork Club on 16th July, 1920.

Smyth was the son of the late George Smyth, Esquire, I.C.S., of Milltown House, Banbridge, Co. Down, and of Mrs. Smyth, daughter of the late Thomas Ferguson, Esquire, of Edenderry House, Banbridge. He was born at Dalhousie, Punjab, on 7th September, 1885. He was educated first at Strangways Private School, going thence to Shrewsbury for two years, then to W. J. Kirkpatrick, Esquire, M.A., and the R.M. Academy, Woolwich, passing first on the list into the latter in September, 1903. At the "Shop" where I knew him as a Cadet, he was distinguished by his brain power, force of character and zeal for all things good, and although not a great player of games, was a thorough sportsman.

Smyth was gazetted 2nd Lieutenant R.E. in July, 1905, and, after the usual two years at the School of Military Engineering, went through the Railway course. He then went to Gibraltar in 1908, where he served in the 32nd and 45th Companies for five years. Here he early showed promise of his outstanding characteristics, viz.: his utter fearlessness and his deep love and care for the men under him. As an example of the former, at the first Point-to-Point race, although he had only lately arrived in Gibraltar and could have known little of the country, he took his own time and showed the way to the whole field down the most appallingly steep and stony hills. He was a bold and fearless rider and hunted regularly with the Calpe Hounds, acting as one of the Whips for several seasons. He was one of the most prominent members of the R.E. Polo Team which was fairly successful in those days. He was an ardent naturalist and lover of nature, and spent much of his time in riding and walking in the Cork Woods and hills in the neighbourhood, studying bird life, but on principle he never took a bird's egg. In order to go freely about the country he studied Spanish and became a first-class interpreter; he spoke Spanish fluently and correctly, but his slight Irish accent caused much amusement to the Spaniards. Even in those early peaceful days he showed great promise, skill

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as an Engineer and boundless energy, and was universally popular, both with his brother officers and the N.C.O.'s and sappers of his Company.

On leaving Gibraltar in 1913 he was appointed to the 17th Field Company at the Curragh at the special request of the O.C. Company, with whom he had served in the 32nd Company at Gibraltar.

In August, 1914. he went to France with the 17th Field Company, and had many opportunities of showing his worth ; no words can do justice to his services during the Retreat in 1914 ; he was the life and soul of the company, his Irish humour and pluck did wonders in maintaining the discipline of the company. He carried out a large number of bridge demolitions in the most gallant manner. On the Aisne he, with his section, were for a considerable time living in the village of Missy, then in the front line, where he assisted the Infantry in every possible way, and was awarded the D.S.O.

He was wounded and lost his left arm when putting up wire entanglements in front of the trenches at Givenchy in September, 1914. His section was caught under heavy shell fire and took refuge under a steep bank ; Smyth would probably have escaped unhurt if he had not gone out to assist a N.C.O. of his section who was wounded. He was a most gallant officer and far above the average in brains, power of concentration and hard work, and care for his men.

Brig.-General C. W. Singer writes of him :—" He was up in arms at once at the smallest suspicion of injustice to those under him ; the last time I saw him in the Spring of 1918 he walked about my " Armstrong " hut for an hour declaiming against what he considered the inadequate amount of leave granted to the men of the battalion that he then commanded ; as he said, no private of an Infantry Battalion could count on being anything but wounded or killed in six months, and that all they had to live for was leave, and yet this was often only granted at intervals of a year or more, so that most men got none."

After recovering from the wounds which cost him his left arm, he joined the 90th Field Company in the 9th Division, and with this Division he served until practically the end of the war. I met him with the 90th Company in June, 1915, near Nieppe. They had just had a very bad shaking up, as their bomb factory had blown up and they had had very heavy casualties—5 officers and many men killed and wounded. Smyth was in command, and had his head bound up, the result of having been blown out of a window. He remained second in command of the 90th Field Company until the battle of Loos, at which the C.O. (Maj. J. D. Monro) was wounded. He then succeeded to the command of the company. and remained with it at Ypres during the winter of 1915–16 and subsequently during the Somme battle. For his services during this period he received a brevet majority.

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He was wounded in the throat on July 13th during the fighting round Trones Wood, and on his return to France was selected to command the 6th (Service Battalion) King's Own Scottish Borderers, with which unit he served continuously, except when in hospital on account of wounds, until October, 1918.

He was altogether four times wounded, once most seriously, during this period, and won a bar to his D.S.O. The circumstances of his winning the bar to the D.S.O. were thus described in the *London Gazette* of 18th July, 1917:—"For conspicuous gallantry and devotion to duty. Although seriously wounded, he remained at the telephone in an ill-protected trench for many hours during a critical time to report the course of events to Brigade Headquarters. He realized that there was no officer of experience to replace him and his sense of duty may cost him his remaining arm, the other having been amputated as a result of a previous wound. He was five times wounded."

An officer who served under Smyth in the 6th King's Own Scottish Borderers writes thus of him:—"I have never met any man who made such an impression on me as Colonel Smyth, and I should have been proud and glad to have done anything for him. He is one of the few men I have met who struck me as really great, and I believe that he would have had a remarkable career if he had lived. It is of interest to know that the members of his old battalion purpose to erect a Memorial to his memory. It is melancholy to think that this is the only thing that we can now do to show our respect and affection for him. The 6th K.O.S.B. knew him as a man of proven courage when he came to command them in October, 1916. All the officers and men considered it a great honour to serve under one who had already singled himself out as a most remarkable leader. At first naturally the men were chiefly impressed by his physical courage. It was freely said that the C.O. never asked a man to do a job which he was not ready to do himself. And the greatest disgrace a man felt that he could incur was the contempt rather than the punishment of the C.O. Many men whose courage had not been above suspicion soon proved themselves to be stout-hearted soldiers under the leadership of Colonel Smyth. I know of several men whom officers had regarded as wasters, who became the most reliable N.C.O.'s of the battalion. But the men also realized that their welfare was looked after in a more thorough manner than was ever the case before. And this they all appreciated greatly; they knew that wherever they went the C.O. would not rest until he had done everything that was possible for them. Similar feelings were shared by the officers. All understood that it was their job to look after the men, but they never knew until Colonel Smyth came how very much could be done. 'Looking after the comfort of the men' was no longer a

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phrase, but became a regular practice. During Colonel Smyth's absence in hospital it was easy to distinguish the officers who had been trained under him. Those of us who were most closely associated with him admired perhaps most of all his moral courage. He was never afraid to risk a rebuff from his superiors if by his action he could help his battalion. One instance among many will illustrate the point. After a battle near Arras on the 12th April the battalion was holding a reserve line of trenches at the Point du Jour. The shelling was intense and caused us numerous casualties. Colonel Smyth was convinced that there was no necessity to hold these trenches at all and he importuned the Brigade until he received permission to withdraw his men to a safer place. Two other points about Colonel Smyth we often remarked on. None of us had ever met a man who could pick up the lie of a country with such amazing facility, and in a battle his grasp of a situation was so clear and quick that it seemed to us almost uncanny.

"We all recognized that he would have risen to the top in whatever profession he entered. That much-abused phrase 'magnetic personality' was rightly attributed to him."

In October, 1918, Smyth was promoted to command the 93rd Infantry Brigade, 31st Division, and remaind with that formation until it was disbanded in 1919.

He then went for a year to the Staff College and on the completion of the course went to command the 12th Field Company at Limerick. He had by this time attained the rank of Bt. Lt.-Colonel. I think he was happy at Limerick, though the peace command of a Field Company must have been a dull occupation for one of his ardent nature; still he was in his own country and could hunt, which meant a great deal to him. While serving at Limerick, he was offered and accepted, a few months ago, an appointment as Commissioner of Police in the province of Munster. His duties being connected with the pacification of the country, and stopping the apparently organized system of police murders which had grown up. Here he had full scope for his great energies and, as the sequel seems to show, proved himself to be an inconvenient adversary to the malcontents in Munster.

He was in London about the 12th July, on duty connected with his work, and that was the last time I saw him alive. Apparently he had been accused by some of the Irish papers of ultra-energetic action of which he was emphatically cleared by the Chief Secretary for Ireland in the House of Commons. He told me, however, that he found the work much more nerve-racking than the war and concluded by saying that he did not think his life was worth five minutes' purchase.

He returned to Ireland from London on Thursday, the 14th, and was murdered in cold blood, in the smoking room of the Cork

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Club, on the evening of Saturday, 16th. This is a thing concerning which his friends can with difficulty write temperately. That he died a soldier's death just as much as if he had died in battle, and that his death was directly due to his devotion to his duty to the King and Empire, is incontrovertible; but it is hard to bear when such a man is called upon to meet such a death.

Sir Hamar Greenwood writes:—"Although my personal acquaintance with the late Col. Smyth was limited to talks I had with him a few days before his death, I can assure you that I share your admiration of his sterling qualities.

'He impressed me greatly by his splendid courage and strong sense of duty. The Irish Government recognized him as a brave and capable officer of the Government, and I, personally, deeply deplore his loss."

Smyth's record of service is as follows:—2nd Lieut. R.E., July, 1905; Lieut. R.E., July, 1908; Captain R.E. October, 1914; Bt. Major, June, 1916; Bt. Lt.-Colonel, June, 1919; Acting Lt.-Col. commanding 6th Bn. K.O.S.B., December, 1916; Tempy. Brig.-Gen. Commanding 93rd Infantry Bde., October, 1918. He was wounded five times—25th October, 1914 (lost arm); 13th July, 1916; 9th April, 1917; 3rd May, 1917; 23rd March, 1918.

His war honours were as follows:—Mentioned in Dispatches, 19. 10. 14; D.S.O., 11. 11. 14; Dispatches, 17. 2. 15; Brevet Major, 3. 6. 16; Dispatches, 1. 1. 16; Dispatches, 15. 6. 16; Bar to D.S.O., 18. 7. 17; Dispatches, 18. 5. 17; Dispatches, 23. 12. 18; Dispatches, 5. 7. 19; Bt. Lieut.-Colonel, 3. 6. 19. He also received the French and the Belgian Croix de Guerre. A glorious record, truly.

After the murder in Cork there seems to have been some difficulty in transporting the body to the North of Ireland for burial, as no driver could be found who would drive the train. However, motor transport was provided as far as Dublin, and the rest of the journey to Banbridge was carried out by train.

The funeral was largely attended. It was carried out with full military honours, a firing party of 100 men with band being furnished by the Bedfordshire Regiment. A large detachment of the Royal Irish Constabulary also attended. The following officers, amongst others, were present:—Major-General H. H. Tudor, C.B., C.M.G., lately commanding 9th Division; Brig.-General Sir Hacket Paine, K.B.E., C.B.; Major Leather—representing Brig.-General Carter Campbell, C.B., D.S.O. Amongst the flowers sent were wreaths from the Royal Irish Constabulary, Officers 17th Infantry Brigade, and Royal Engineers, Cork. The route to the cemetery was lined with thousands of sympathisers

Such is the record of Lieut.-Colonel Smyth's public life. It is permissible, however, to say a word about the man. I knew him as a boy at the "Shop" and served with him afterwards both in

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peace and in war. He was a peerless soldier, in every true sense of the word, and the *beau idéal* of a British officer. He was a tiger in battle, but withal the most human and sympathetic of men. Some of his greatest friends were children, and his life was as simple as a child's. His courage was of an unequalled variety. Physical fear he did not recognize but it was his moral courage that was his greatest ornament. He feared no man in standing up for what he thought was right and true; and hypocrisy was his horror. You could always count on Gerald Smyth telling the truth, no matter how unpleasant, without dismay to anyone, whether above or below him. His regard and care for those placed under him was pathetic: I wonder if they ever realized how much their welfare meant to him?

The memory of such a man is a priceless thing—we older people have not long to follow his example, but, to the rising generation, that example of fortitude, of honour and of truth, is of more value than many exhortations.

G. WALKER.
Brig.-General.

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REVIEWS.

A SHORT HISTORY OF THE 6TH DIVISION.
AUGUST, 1914—MARCH, 1919.

By MAJOR-GENERAL T. O. MARDEN.

The title is somewhat of a mis-nomer. "History" it is not, at least as generally understood, but as a brief narrative of events this little volume will serve the purpose of its author, which is, as he explains in his preface, "that all who served with the Division for any period between 1914—1919 may have a record to show that they belonged to a Division which played no inconspicuous part in the Great War." In the 80 pages of the narrative are crowded the events of five years, so that many minor events, full of interest to those who took part in them, are necessarily omitted or only just mentioned; but where General Marden has allowed himself a somewhat fuller scope to his descriptive powers, and to give some little detail, the relation is so crisp and clear that one can only regret that he was not rather more ambitious and had expanded his work to greater dimensions, accompanying it with some detailed maps. Let us hope he may do so later, for it is only by such "sectional" histories that the true history of the conduct of the war in detail can be really learnt. No doubt official and other comprehensive histories will appear, but to the normal brain they will contain so much extraneous matter that the details of how a division carried out the various duties entailed upon it will be lost to the student of after-times and remain buried in immense masses of general information. The 6th Division, like all the Old Army Divisions, was essentially what may be termed a "County" regiment unit, with a leavening of the Rifle element. It carried no glamour of overseas or special national characteristics, and its history is typical of many others, which, not appealing to the general public by dint of newspaper reporting, nevertheless inspired in their members and in those Higher Units under whom they served, a quiet confidence in their adaptability, steadfastness, resourcefulness and discipline. Launched in the War, under commanders and staff second to none, the division maintained the high reputation it gained in the early phases. Perhaps the most trying period of all for the division was that in the Loos salient, and it speaks volumes for its efficiency and morale that so shortly after its experiences there it should have been selected to take part in the Cambrai attack. During the whole of the time it was in front of Lens the main object of the Army and the Corps appeared to be to secure and hold Hill 70 by means of a battalion attack. Time after time did the 16th Brigade secure the

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objective only to be driven out by a concentric fire of most powerful hostile artillery from the North, East, and South. Four battalions supplementary to its own four were passed through the 16th Brigade for this purpose and large casualties were incurred; no doubt the object, to turn the enemy out of their post of observation, was highly important, but throughout the small local attacks is illustrated the impossibility of holding a very limited objective in the face of heavy artillery concentration. This division learnt that fact at Hooge and truly it was a case of "theirs not to reason why." One could wish that General Marden had expanded a little over our Territorial Units which joined about December, 1914. How thoroughly and warmly they were welcomed all who were there at the time can remember, and their keenness and soldierly qualities from the earliest days of their arrival cannot be too highly praised. Experience gained of them at that time was of much value to those connected with them in later stages of the war. Not the least interesting and useful portion of this little volume are the Appendices. The Battle Casualties, List of V.C.'s, Diary, Order of Battle at different periods, and changes in Commands and Staffs. A perusal of the volume leaves the impression that the 6th was an essentially "happy" Division. It certainly was during the early period; at a time when much was new, much had to be learned, when our needs were greatest, the junior ranks knew that those above them had a true appreciation of their welfare and shared their dangers and their troubles. So may it always be.

G. C. KEMP.

THE CHEMICAL ANALYSIS OF STEEL WORKERS' MATERIALS.

By F. IBBOTSON, B.Sc., F.R.Sc.I, etc. (Longmans, Green and Co.) is intended chiefly for the use of the chemist, and deals with the quantitative analysis of iron and steel, steel making alloys, ores, fuels, slags, and of refractory materials.

H.L.L.

THE YEAR-BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1920.

"The Year-Book of Wireless Telegraphy and Telephony" for 1920 has been published by the Wireless Press, Ltd., within the past few weeks. The volume is the eighth annual issue of the well-known handbook, and fully comes up to the high standard of its predecessors. In order to keep the volume within bounds, as regards bulk, much of the matter contained in the current issue has been printed in smaller type than that used in the case of the earlier issues—at the same time some rearrangement of its contents has also been carried out. A considerable amount of new matter appears in the current issue, but the size of the handbook has not been increased in consequence; indeed, the Year-Book for 1920 contains 15 pages fewer than last year's issue. The volume under notice contains 33 excellent photographic illustrations of wireless

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apparatus and plant ; in several of these illustrations valves, as might be expected from the important part they play in wireless telegraphy and telephony now-a-days, occupy a somewhat prominent position. So far as its contents are concerned, the range of subjects dealt with in the volume for 1920 remains practically the same as that in its immediate predecessor. The notes dealing with the Record of the Development of Wireless Telegraphy have been brought up to date. The year 1919, it is pointed out, brought forth no revolutionary changes in the field of radiotelegraphy : it has constituted a transition period from war-time activity to a return to conditions of ordinary commercial work. This feature of the wireless situation has been more or less reflected in the many papers dealing with wireless matters which have been read before the various Societies and Institutions. In the Section of the volume dealing with National and International Wireless Laws and Regulations the most noticeable feature among the changes introduced consists in the sketch maps of the various countries referred to in this Section. These maps show the positions of the wireless stations in each of the countries, the distinctive character of the stations indicated on the maps, *e.g.*, in the case of Great Britain the stations are indicated as belonging to one or other of the following categories, (1) Public correspondence with ships ; (2) Naval Official Traffic or Government Traffic ; (4) Direction Finding Service ; (5) Transocean Public Services ; (6) Experimental stations or Instructional stations ; (8) High power special service to ships (Transmission) only ; (9) Lightships ; (11) Private stations ; (12) Under construction ; and (13) Aviation station only. These maps undoubtedly add much to the value of the information contained in this handbook. The amount of the information contained in this Section of the volume shows a growth in relation to that published in the issue for 1919. This increase is due to two causes ; first there is the inevitable new legislation, etc., in the countries concerning which information has been given in preceding volumes, and, secondly, there are the laws and regulations in force in various parts of the world, not included in previous issues, *i.e.*, laws, etc., which now appear in the handbook for the first time. The additional information included in the case of Great Britain comprises the Air Navigation Regulations, 1919 ; the Circular to Owners and Masters of British Merchant Ships issued in November, 1919, by the Admiralty relaxing the restrictions on the use of Wireless Telegraphy ; the Merchant Shipping (Wireless Telegraphy) Act, 1919 ; and an extract from the Convention relating to the International Air Navigation (1919). Among the parts of the world which find mention in this Section for the first time are :—Ascension Island, Bolivia, Cocos-Keeling Island, Costa Rica, Crete, Cyprus, Korea, Liberia, Malaya, Poland, etc. The lists of Land Stations and Ship Stations have been brought up to date, and the notes, which in former issues were printed at the ends of these lists, have been brought up and are now placed against the appropriate stations in a Column of Remarks, thus making the notes more convenient for reference purposes. Again, in many cases in which the ranges of stations were omitted (no doubt designedly) in last year's issue the blanks have been filled in with the required data. The steady growth in the numbers of the stations is

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evidenced by the increased numbers of pages devoted to this Section of the volume: the Land Stations occupied 65 pages in the volume for 1919, they occupy 85 pages in the current volume; the increase in Ship Stations is very marked, the number of pages devoted to them has gone up from 159 to 232. The scope of the Section dealing with International and Weather Signals has been somewhat widened; it has in consequence been re-named and is now designated the Meteorological Section. This Section contains two articles of considerable interest, viz:—(a) "Radio-Communication and Meteorology," by Lt.-Col. E. Gold, D.S.O., F.R.S., and (b) "Wireless and Time," by Arthur R. Hinks, M.A., F.R.S. The remaining part of this Section deals with International Time and Weather Signals and describes the arrangements current in relation to these matters in various countries. A new feature in the current issue of the handbook, and one which adds much to the interest of the volume, consists in the enlargement of the Special Articles Section by the inclusion therein of National Resumés containing an account of the Technical Progress made in Radiotelegraphy in certain countries during 1919. The countries dealt with in the volume for 1920 are:—France, Germany, Great Britain, Holland, Italy, Japan, Norway and the United States of America. The General Articles in this Section are five in number, and are of the same high standard and equal in interest to those contained in previous issues. The subjects dealt with are:—"The Progress of Wireless Telephony," by W. T. Ditcham; "Valve Amplifiers for Shipboard Use," by F. P. Swann; "Wireless Telephony and its Application to Aircraft," by Major C. E. Prince, O.B.E.; "Direction Finding," by G. M. Wright; and "The Berne Bureau." In the Patent Section is contained a most valuable summary by I. Shoenberg of the Valve Patents for 1919. Tables are also given of British Patent Specification relating to Telegraphy published during 1919; a name index to the British Patents published during 1919; and two similar tables relating to the U.S.A. Patent specifications. By way of innovation there has been added an Aviation Section; it contains (a) an article entitled "Radiotelegraphy and Aviation," by Major Robert Orme, B.A.; (b) a tabular list of Aviation Stations; and (c) miscellaneous items of interest. The Useful Data Section has undergone contraction. The Editor points out that the general increase of matter renders it impossible to continue the development and expansion of this Section. In consequence, in order to meet the phenomenal growth of the radio art, a separate volume has been compiled and is being published by the Wireless Press, Ltd., under the title of "Standard Tables and Equations in Radiotelegraphy," a title which is descriptive of the contents of the publication. The portions of the Section dealing with Wireless Terminology and General Information are included in the volume; many new definitions appear under the heading "Wireless Terminology." The value of the Literature Section has been much enhanced by the re-arrangement which has been introduced in the current issue. The matter contained in this Section is now arranged under three heads:—(a) New Books published in 1919; (b) Resumé of Articles published in 1919; and (c) Standard Publications on Wireless. As in former years, so in the case of the current issue, much useful information is given in

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relation to the Companies engaged in the Commercial Development of Wireless Telegraphy. Further, the Biographical and Code Signal Sections are also included in the volume as in past years. It will be apparent from the foregoing brief review of the contents of the Year-Book for 1920 that the volume is indispensable to those who are interested in Wireless Telegraphy and Telephony, whether as a hobby or commercially or officially.

W. A. J. O'MEARA.

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 113.—*The Strength of the German Army.*—The leading article consists of an argument to prove that the German Army should not be less than 200,000 strong. It is stated that this number was just, and only just sufficient to prevent a complete collapse during March, and this in spite of the fact that Berlin and the whole of Bavaria remained comparatively—and very fortunately—fairly quiet, and also that the auxiliary forces were still in existence and helped to maintain order. Further arguments are that Foch himself favours 200,000, knowing that such a number need cause no anxiety to France and that with less the fulfilment of the Treaty would be impossible ; also that the flooding of the labour market with 100,000 demobilized soldiers and 15,000 naval troops of thoroughly unreliable and self-seeking moral would be disastrous under the present conditions of German economic life. Surprises may be expected from the East, and it must not be forgotten that in Berlin alone there are 63,000 Russians, disciples of Bolshevism ; and what will happen when Germany joins the League of Nations and is called upon to take action on its behalf ? Conditions now are quite different to those in force when the Treaty was drawn up and unless the *Entente* wishes to see all European culture fall a victim to Bolshevism, it will have to leave Germany her 200,000 strong army. It must be admitted that a strong case is made against a further reduction, and the outcome of the Spa conference seems to show that it is so recognized. At the moment the references to action on behalf of the League of Nations, presumably against the Bolsheviks, appear to have a prophetic ring about them.

The Genesis of the Battle of the Marne.—General Le Gros' book is hailed as one of the few emanating from French sources which treats this much-discussed campaign in a professional manner. The others, it is said, handle it either with a view to propaganda, or as a romantic miracle. Its favourable reception is perhaps due to the fact that it gives more credit to Galliéni, who is dead, than to Joffre, who lives ; or to the English Army, which also lives.

The Fulfilment of the Turkish Treaty.—The difficulties of the *Entente* in view of Mustapha Kemal's nationalists are discussed. Kemal will, the *M.W.B.* thinks, take to guerilla warfare in the interior of Asia Minor and become a thorn in the flesh of the *Entente*.

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The Belgian Garde Civique in 1914 is another "hate" book which throws all the blame for the Belgian atrocities on the Belgian Government. It is probably intended to take effect in the forthcoming Leipzig trials of war criminals.

No. 114.—*The March on Paris and the Battle of the Marne,* 1914.—Generals von Hausen and von Bulow have already published their accounts of the actions of the 3rd and 2nd Armies in 1914, and now we have by von Kluck his account of the 1st (right flank) Army in "The March on Paris and the Battle of the Marne (1914)." It is based on reports written in the winter of 1914, when the memory of events was still fresh. Von Kluck begins with an account of how he passed his 5 corps through the defile between the Dutch frontier and the 2nd Army; no easy task, and one only accomplished by much careful staff work. After the fall of Liége he was placed under the 2nd Army and found this inconvenient though necessitated by the inaccessibility of G.H.Q. at Luxembourg. Another circumstance which made his task harder was the ignorance of G.H.Q. as to the moment when the British forces would make their presence felt. After the fight at Mons and during the subsequent following up of the British Army, he had indifferent help from G.H.Q., whose orders were seldom clear and sometimes contradictory, but the steps taken to meet the threat from Gallièni and Maunoury had placed him in the best of positions when "Fate in the person of Lieut.-Colonel Hentsch brought orders from G.H.Q. to break off the fight and retire." Von Kluck personally neither saw nor spoke to Hentsch. The riddle of the Marne is apparently but little nearer solution. Hentsch based his decision on the situation of the 2nd Army, but von Bulow has already stated that he was anxious not about his Army but about that of von Kluck. It is extraordinarily unfortunate, that the one man in whose hands these so far-reaching decisions lay, should have died without, it appears, ever committing to paper a record of his decisions and the considerations which influenced him.

The Legend of the Superiority of the French Artillery in the War is declared to be based on what von Tirpitz calls "That trait in the German character which always belittles whatever is German, and delights to look on the worst side of things." The writer seeks to prove that the German gun was better by stating that in August, 1914, a detachment of German gunners, after examining a captured French gun, declared that they preferred their own. It would have been extraordinary if they had not done so.

Military and Political Events in the Anglo-Asiatic Empire.—This is an account of the proposed re-organization of the Persian forces, which states that the greed, laziness, and conceit of the Persians will make the English task a difficult one. England, however, will spare neither men nor money to erect a buffer State on the "glacis of India" to withstand a resurrected Russia.

Seaweed as Forage for Horses.—A brief account of French experiments in the use of seaweed as forage for horses is given. Apparently horses in light work could be kept going on a ration of three parts seaweed to one part oats, the seaweed being specially washed and dried before use.

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No. 115.—*The Military and Political Situation in the World.*—Comments on the Polish operations lead to a comparison between German Poland in pre-war days and Ireland as at present. The British Government is looked on as a model of determination and firmness and regret expressed that Germany treated her Poles with such excessive moderation and weakness in the days before the war. The condition of the French Army is stated to be far from satisfactory. In spite of talk, very little has been done to make conditions of life for the French officer and particularly for the married ones at all bearable, and large numbers are stated to be leaving the Army for civil life whenever they get a chance.

The German Retreat in 1914.—Lieut.-General Tappen, who was Moltke's Director of Military Operations Branch of the General Staff, attributes the failure, as usual, to the lack of the two Corps which had been withdrawn from the right wing for Russia. He adds, however, that it was at that time the intention to withdraw 6 Corps, 2 from each wing and 2 from the centre, and that the 2 from the right wing were only the first instalment. The others were, however, never taken, owing to the unfavourable situation which developed in France. The position of G.H.Q. is also blamed. Tappen says it should have moved from Coblenz on the 25th August, and not have waited till 30th, and when it did move it should not have gone to Luxembourg, but to Charleroi, or at any rate have sent an advanced echelon there. He attributes the lingering in Luxembourg not only to the technical difficulties in moving G.H.Q., but also to "a certain sluggishness" that apparently existed.

Hatred of Officers.—This is apparently still being stirred up. By pamphlet and cinematograph the officer is held up as an object for scorn and hatred, and no abuse is too vile to fling at him, in spite of the fact that he bore during the war a quite disproportionately heavy share of the casualties.

No. 116.—General von Hausen, who commanded the 3rd Army, gives some interesting comments on Tappen's book, mentioned in No. 115, and discusses in some detail the orders given to the 11th Corps for its move back to Malmedy on the way to Russia. These appear to have been curiously inexact and, like so many of the more important orders given by G.H.Q., to have left a great deal of latitude to the subordinate commander. Probably the strict uniformity of German training and doctrine obviated the dangers which from such latitude might otherwise be expected to arise.

No. 117.—*Strength of the German Army.*—Further arguments in favour of a stronger army than the 100,000 men hitherto decided on are given. Austria with six million inhabitants has a 30,000 strong army, but Germany, with sixty million, has not 300,000, but only one-third of this number. Quite apart from the unsettled internal conditions of Germany, the increased length of her land frontiers demands an adequate army. Before the war she had 1,000 kilometres of Eastern frontier, well fortified and often defined by well-marked natural features with a properly organized railway system behind them. Now she has 1,500 kilometres of undefended frontier, drawn without regard to natural features, and naturally finds her railways no longer appropriate to their defence.

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Consideration of the present situation in Eastern Europe leads the writer to demand a minimum of 300,000 men if Germany is ever to be in a position to pay, by her steady labour, the enormous damages levied on her.

Bestiality in the War.—Another series of the pamphlets alleging cruelties of all kinds on the part of the French towards German prisoners of war appears; also one entitled "England's crimes at sea." The purpose of the books is, of course, to prejudice the Leipzic trials.

No. 118.—*The Organization of the new German Army.*—The writer points out that quite apart from the insufficiency of the numbers allowed (100,000 men) the organization is quite inappropriate to the most probable tasks which this army will have to perform. It is at present divided into 7 Infantry Divisions (*Reichswehr* Brigades) and three Cavalry Divisions. The Infantry Division has 9 Battalions, one squadron and 9 batteries, besides a pioneer battalion of 3 companies and a bridging company. The addition of Army troops in the shape of Heavy Artillery, aeroplanes, anti-aircraft defence and railway troops is urgently required. The mere doubling of 100,000 will not meet the case, and internal defence cannot be assured unless the correct organization is allowed. This, the writer thinks, should take the form of 4 Corps, 12 Infantry Divisions, 3 Cavalry Divisions, and 5 Mixed Brigades with appropriate Army Troops as above mentioned and, for the present at any rate, some special frontier brigades as well.

With Field-Marshal von Mackensen from Bukarest to Salonica describes how the veteran Field-Marshal was taken near Budapest on his way back from Roumania in November, 1918, and sent down to Salonica "at the instance of the French, who, finding they could not conquer him in honest warfare tried to arrange it that he should die of fever in Salonica."

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

March, 1920.

EXTRAPOLATIONS.

(This article is headed by an Editorial note disclaiming responsibility for the opinions expressed, and hoping they may lead to useful discussion).

It is somewhat presumptuous to attempt to determine the form that the battles of the future will assume, by prolonging, with suitable interpolations, the curve of determined results, but our deductions may not be without use. Recent writings have drawn attention to the scientific evolution of warfare, and the military organization which may result from it. Many of our arguments are borrowed from the Navy, which is the child of industrial art, and has evolved with it. The probable aspects of war, tactical and strategical, will be studied; the military organization which may be the result is only touched upon.

The superior arms are first considered. By this term is meant those the evolution of which has affected the tactics of all the other arms

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The arms will be taken in the following order :—aviation, the artillery of attack, artillery, fortification, infantry, cavalry.

Although aviation was not the decisive arm in the late war, time for its development being wanting, it may end by proving its superiority over all others. So far the only other arm which has avoided its attentions is the submarine. Aircraft are incontestably superior to all terrestrial appliances, combining as they do power of fire and mobility. They must submit to the same laws as the other arms in that they must engage a similar arm on the side of the enemy, and must also act intimately with the other arms of their own side. The mastery of the air depends almost entirely on the superiority of the chasing aeroplanes, and on its acquirement depends all the other duties of aircraft. Mastery of the air alone ensures concealment of one's own movements, and usurps one of the functions of cavalry.

Bombardment of the rear areas has its uses, but at the moment of attack it would be preferable to combine all arms, including aviation. If this is not possible during the artillery battle, aircraft must be brought up directly the infantry advances. Insignificant obstacles often stop the progress of infantry, and it is allowable to hope that aer'al bombardment may dispose of these. Besides aerial bombardment may take the place of all heavy artillery fire, the high cost of the machine, and the imprecision and intermittence of its fire being the only arguments so far against its use.

Aeroplanes are now commonly used for transport, but their capacity is so restricted that for many years to come they are not likely to be much used except for carrying bombs, and airships are too slow and unwieldy.

While now the freedom of the seas is being bitterly discussed, there may come a time when the freedom of the air may become a more intolerable tyranny. The British air service is now the finest in the world. Confusedly, no doubt, England recognizes that she can only reign at sea so long as she can reign in the air. It is difficult to forecast what submarine navigation may develop into, but in this may be found the means of controlling the all-powerful British air-power.

It is possible that the aerial army may triumph over all terrestrial methods of attack and defence, and become the exclusive arm of the future. At present its radius of action is too restricted, nor can it ensure the possession of the ground it dominates ; still, it might deal such a blow on a vital point as to oblige an enemy to capitulate without any necessity for occupying his territory.

Attack artillery has been one of the elements of victory, and foremost comes the tank ; still it must be remembered that aviation will rapidly develop commercially, while attack artillery can only evolve slowly. The tank may replace infantry ; it has all the mobility and power of resistance of the latter, and perhaps greater destructive power. The employment of masses of tanks may be foreshadowed ; even duels between opposing fleets when, owing to unfavourable weather, aircraft and artillery cannot participate. Comparison with naval engagements is not quite possible ; tanks can obtain cover from ground which is not

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possible at sea. Motor-drawn guns could intervene with effect if, already possessing superior speed, they are of larger calibre, unless the tanks are sufficiently armoured. Aircraft are a formidable antagonist to the tank, and duels between them may be expected.

The tank is reproached with being unable to secure possession of conquered territory, but in a war of movement it would appear to be as capable as infantry of doing so, on condition that it can conceal itself and always be ready for action. Tanks must be of different design for various duties. Against fortified positions the light tank showed its superiority, since its worst enemy at that time was artillery firing direct, and it offered a small target, but to meet large heavily-armed tanks similar vessels of high speed will be necessary. The greatest obstacles to tanks are water courses, and tanks must be accompanied by bridging material.

Artillery perhaps received the greatest attention during the war and its proportion to the other arms, and its calibres, increased. Gas shells were used against troops. It is possible that bombing aeroplanes may replace the costly heavy artillery, and tanks or similar engines and fighting planes will use the medium and small calibres. Against fortified positions artillery will be largely used, but must be of great mobility, and the difference between artillery as at present carried, and the tank, will continually decrease. Anti-aircraft guns will also be requisite. Artillery has for the present proved its superiority to fortifications. Tanks have made lines of trenches obsolete. Natural obstacles such as mountains and rivers will form the framework of future fortifications, but such positions can be reduced by appropriate bombardment.

This is the era of machinery, but machines are costly, and subject to continual improvement. Will a false security be sought in fortification, which also to be of use must be kept up to date? It would be better during peace to spend the money on engines of war, and to construct the fortifications in time of war. Probably permanent fortification will be confined to the minimum imposed by the necessity for protecting the war machines in subterranean shelters, since in the future aircraft will be the arm of surprise.

While the strength of armies has increased during the war, the proportion of infantry has decreased. At this date the foot-soldier only occupies the ground; he does not conquer it. In the age of the sword infantry fought in masses; on the introduction of fire-arms he extended in line, and now he fights in extended order and must have cover. Trenches have taken the place of rifle-pits, mining is almost impossible. Man cannot fight against machines. The weight of material he must carry is excessive, but during the last war rapid transport for him from place to place was found necessary, and fitness for marching was a secondary consideration. Certainly in future rail and motor transport must be provided for the infantry.

In old days the cavalry decided the battle; rifle fire has converted it into mounted, *i.e.*, very mobile, infantry. Other more rapid means of conveyance are used at the present day, and the air service has taken

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the place of cavalry in reconnaissance, the more so as it cannot be held up by parties of infantry. The day of cavalry is over; pursuits will be carried out by tanks to break up resistance, with the higher-paced armoured car and lorries with materials for surmounting obstacles, motor-drawn guns, and infantry in motor vehicles, connection, and perhaps supply, being maintained by aircraft.

Science has also improved methods of communication and other services. The proportions of the various arms will alter as science advances, and generally in favour of the superior arms.

Aircraft being the most mobile arm, overwhelming attacks by them may be expected directly hostilities are declared, but the enemy aerial army conquered, the question will not be entirely settled until the air service has acquired complete supremacy over the other war machines. The shock of the land armies will come later, and in it the aircraft will participate. A decision once obtained will be more complete than of old; machines can be replaced less easily than men. Naval battles present an analogy. Future wars will be more rapidly launched, and more promptly terminated.

This scientific conception of war brings into prominence the strategic unity which ought to exist between all operations, aerial, terrestrial, and marine.

As victory should incline to the nation which possesses the most modern and numerous machines, preparation for war will demand great sacrifices. Armaments may be limited tacitly or by agreement, but even total disarmament will not guarantee peace, as commercial machines would be brought into use. But the more scientific engines of war become, the more they differ from the similar appliances of peace, as exemplified by the battleship. Progress leads to specialization, and the modern army will have to be professional if it is to make the best use of its machines, but can be of reduced numbers, owing to the scientific appliances with which it will be equipped.

Transformations in the German Army

(*From* 11*th Nov.*, 1918, *to* 11*th Nov.*, 1919).

The Reichswehr.—The support of the volunteer corps enabled the Government to pass victoriously through the troublesome period following the revolution of November, 1918, and gave the idea of voluntary recruiting tempered by selection. The Reichswehr is organized on the model of and retains the personnel and traditions of the old army. In the press of the extreme left, *Die Freiheit*, 5th April, 1919, this is fully brought out. Briefly it states:—"The army is the direct continuation of the old army; it is the consolidation of re-action and of the counter-revolution, and a provocation to the proletariat." The German Government has done its best to hide this fact from foes at home and abroad, and the task has been rendered more easy by the curbing of the Spartacists, and dissensions among the Allies.

The Act creating the Reichswehr came into force on 6th March, 1919. The force was to consist of two categories (i) The Reichswehr properly

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so called, comprising *Reichswehr truppen* (the large territorial commands) *Gruppen truppen* (not brigaded) Mixed Brigades, heavy or light, and (ii) the *Volkswehren*, intended to maintain public order, but attached to and under the same regulations as the *Reichswehr*. Recruiting was to be regional. The initial proposal prescribed 18 brigades (6 heavy, 12 light) organized in 2 *Gruppen kommandos*, a total of 241,000 men, At first matters progressed slowly, but from May to October progress was more rapid and continuous. In the latter month the *Reichswehr* consisted of 450,000 men, or 43 brigades (23 heavy, 20 light) organized in 4 *Gruppen kommandos* comprising also *Gruppen truppen* of unknown quality and numbers, and bodies of *Volkswehr*.

Tables are given showing the composition of the 43 Brigades. They are practically divisions at reduced strength, and could quickly be put on a war footing as such, since the staffs of formations have been retained. The depots, demobilization centres, etc., of the old army are also still in existence. Officers are still being appointed, not to fill vacancies, but as a reserve, lieutenancies being granted to senior N.C.O.'s to give the force a veneer of democracy.

The students of the universities are generally pan-Germans and militarists, and provide useful recruits for the N.C. and commissioned ranks.

A table of pay and allowances shows that a soldier with three children and ten years' service would receive 5,000 marks a year in addition to food and quarters. Leave is at the rate of 15 to 35 days a year according to length of service.

In place of soldiers' councils, confidential agents (*Vertrauens leute* are elected by the secret ballot of their comrades and delegated to the next higher unit, and so on, up to and including the War Ministry. Their powers are strictly limited, and do not embrace interference with the command, but are confined to questions of interior economy, and on the whole strengthen the bonds of discipline by providing the commanders with a means of probing the feelings of their subordinates. Sports of all kinds are encouraged. The result is that the *Reichswehr* has a military value scarcely inferior to that of the pre-war army.

In August, 1919, the War Minister ordered the reduction of the *Reichswehr* to 225,000, organized in 20 mixed brigades. This was a mere blind ; by that date the reserves were well organized, and repatriated prisoners were about to arrive. The brigades were distributed in 7 *Wehrkreise*, replacing the suppressed Army Corps regions, grouped in 4 *Gruppen kommandos*. Even this reduction was deferred on various pretexts, and on 11th November, 1919, the *Reichswehr* still comprised about 30 brigades (say 450,000 men) composed of the best of the 43 original brigades, the remainder being re-named *Überplan mässig*, and to be retained until 1st February, 1920. The new organization is therefore not a reduction, but a distinct step towards the consolidation (*i.e.*, Prussianizing) of the Army. Also to the Minister of the Reichswehr has been delegated the supreme command of the land and sea forces.—(*To be continued*).

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GERMAN OPINIONS ON THE WAR.—DEDUCTIONS FROM THE WORLD WAR. By Lieut.-Gen. von Freytag Loringhoven, translated by M. Forget, and continued from the January number.

It must be allowed that if trench warfare assumed such importance in this war it was due to the ineptitude of our enemies, and had the contending forces been equal in efficiency it would have been impossible for us to have maintained our position so long, owing to their numerical superiority. They should have been able to ensure a war of movement, but failed to do so, and our weakness in numbers prevented us from advancing. All we could do was to forestall the enemy's attacks in some cases, as at Verdun, and in the Venetian Alps, but generally the initiative was with our foes.

A method we adopted to give some appearance of manoeuvre to the struggle and to save losses among our troops, was to allow the enemy to penetrate our lines on narrow fronts, and then repulse him with reserves collected in rear, but owing to our lack of artillery the procedure could not be applied on extended fronts. An essential condition for success was the presence of sufficient reserves for the counter-attack, and if the latter had failed on a wide front it would have entailed the abandonment of large tracts of enemy territory, and we could not afford to forego the industrial riches of the North of France, or risk the bad moral effect of such losses. Our withdrawal from certain sections of the front near the Ancre, Somme, and Oise at the end of the winter of 1916–17, was only made when the general situation had been considerably modified and stronger and more favourable positions had been prepared in rear. It resulted in a surprise, and considerable losses, to the enemy, gained us time and greater security, and prevented waste of strength.

Arguments follow, drawn from the writings of Frederick the Great and Napoleon, justifying a resort to field fortification as a means to conservancy of force in certain circumstances, but it is not intended to imply that trench warfare will necessarily play such an important part in future wars. A war can only be won by beating the armed forces of the enemy, but may be distinguished by many of the characteristics of trench warfare, and owing to the necessity for bringing into action the numerous appliances now obligatory, will be a slow process. For a struggle of this nature the German training is exactly what is required, and is in fact superior to that of all other armies. Moltke wrote that a strategical offensive may well be combined with a tactical defensive. If in 1870 the Germans always took the offensive, and captured the enemy's strongest positions, it was at the price of severe losses. It may be wiser not to attack until several enemy attacks have been repulsed.

The fundamental ideas of warfare as held prior to 1914 should be retained, but improved by the experiences of the late war. Perfection may be reached for, but is never attained. So the recent lessons must not be given weight out of proportion to those of earlier wars. It must be remembered that the campaigns on the East and West fronts were entirely different. Although Napoleon said that for a commander to achieve success he ought to change his tactics every ten years, a leaven of conservatism is desirable in military progress, which should proceed gradually, and not by leaps and bounds.

A. R. REYNOLDS.

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RIVISTA DI ARTIGLIERIA E GENIO.

April—May, 1920.

MAGNETIC-MECHANIC ANALYSIS OF IRON AND STEEL.

Up to the present time the methods largely in use for the analysis of the characteristics of iron and steel (chemical analysis, micrographic, proofs of hardness, resistance to strain, etc.) have been limited to a small portion of the material under examination. It is now reported in the *Ingegneria Italiana* that a rigorous scientific method has been adopted based on the precise correspondence between the mechanical properties of iron and steel and the magnetic characteristics. This new method is founded on the principle that there is only one series of magnetic characteristics corresponding to a given series of mechanical characteristics; and, inversely that there is only one series of mechanical characteristics that corresponds to a given series of magnetic ones. The magnetic characteristic that can be practically measured is its *permeability*; and the method now employed is the invention of Foley of a *permeametro*, a simple and practical apparatus, by which the results of the operations can be read on a galvanometer. Varying according to the intensity of the magnetic field, the instrument, which is properly graduated, indicates the quantity of the lines of force that traverse one square centimetre of the surface under examination. It is easy to construct a diagram shewing the relationship between the intensity of the current and the number of the lines of force induced, thus obtaining a characteristic curve for each description of metal. This new method of measurement presents special advantages of which the following may be mentioned:—

(*a*) the possibility of continuous proofs in the various stages of work, without causing waste of material;

(*b*) the possibility of recognizing the special products, which, owing to various circumstances cannot be precisely seen at the first view obtained during the production;

(*c*) the impossibility of errors of a kind so frequently made in the ordinary systems—for example, the difference between two proofs of tempered steel made in a different manner, which are not noted by means of mechanical mensuration, but which are clearly seen in magnetic diagrams;

(*d*) the possibility of following an entire production step by step; for example, each article produced has its characteristic curve; a steel wire for an aeroplane can be completely tested and the smallest defect of homogeneity detected.

From this simple enumeration it may be seen that this new method of measurement will give certain great advantages in industrial metallurgy.

E. T. THACKERAY.

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CURIOSA MATHEMATICA, No. 2.

Solution by Lt.-Col. A. J. C. Cunningham, late R.E.

All integers from 1 to 100 expressed by four 4's.

The only symbols here used—(besides the usual arithmetical symbols)—are $n!$ means $n(n-1)(n-2) \ldots\ldots 3.2.1$. Γn means $n! \div n$.

1 $4 \div 4 + 4 - 4$	26 $4! + (4+4) \div 4$	51 $4! + 4! + 4 - \Gamma\sqrt{4}$	76 $4 \times (4! - 4) - 4$
2 $4 \div 4 + 4 \div 4$	27 $4! + 4 - 4 \div 4$	52 $44 + 4 + 4$	77 $(4 - \Gamma\sqrt{4})^4 - 4$
3 $(4+4+4) \div 4$	28 $4(4+4) - 4$	53 $4! + 4! + 4 + \Gamma\sqrt{4}$	78 $4 \times (4! - 4) - \sqrt{4}$
4 $4 + 4(4-4)$	29 $4! + 4 + 4 \div 4$	54 $4! + 4! + 4 + \sqrt{4}$	79 $4 \times (4! - 4) - \Gamma\sqrt{4}$
5 $4! \div 4 - 4 \div 4$	30 $(4+4) \times 4 - \sqrt{4}$	55 $4! + 4! + \Gamma 4 + \Gamma\sqrt{4}$	80 $4 \times 4! - 4 \times 4$
6 $4 + (4+4) \div 4$	31 $4(4+4) - \Gamma\sqrt{4}$	56 $4! + 4! + 4 + 4$	81 $4 \times (4! - 4) + \Gamma\sqrt{4}$
7 $4 + 4 - 4 \div 4$	32 $4 \times 4 + 4 \times 4$	57 $(4! + 4) \times \sqrt{4} + \Gamma\sqrt{4}$	82 $4 \times (4! - 4) + \sqrt{4}$
8 $4 + 4 + 4 - 4$	33 $4 \times (4+4) + \Gamma\sqrt{4}$	58 $4 \times 4 \times 4 - \Gamma 4$	83 $(4 - \Gamma\sqrt{4})^4 + \sqrt{4}$
9 $4 + 4 + 4 \div 4$	34 $(4+4) \times 4 + \sqrt{4}$	59 $(4! + \Gamma 4) \times \sqrt{4} - \Gamma\sqrt{4}$	84 $4 \times (4! - 4) + 4$
10 $4 + 4 + 4 - \sqrt{4}$	35 $\Gamma 4 \times \Gamma 4 - 4 \div 4$	60 $4 \times 4 \times 4 - 4$	85 $(4 - \Gamma\sqrt{4})^4 + 4$
11 $4! \div \sqrt{4} - 4 \div 4$	36 $4(4+4) + 4$	61 $(4! + \Gamma 4) \times \sqrt{4} + \Gamma\sqrt{4}$	86 $4 \times (4! - 4) + \Gamma 4$
12 $4! \div \sqrt{4} + 4 - 4$	37 $\Gamma 4 \times \Gamma 4 + 4 \div 4$	62 $4 \times 4 \times 4 - \sqrt{4}$	87 $4 \times (4! - \sqrt{4}) - \Gamma\sqrt{4}$
13 $4! \div \sqrt{4} + 4 \div 4$	38 $44 - 4 - \sqrt{4}$	63 $4 \times 4 \times 4 - \Gamma\sqrt{4}$	88 $44 + 44$
14 $4 + 4 + 4 + \sqrt{4}$	39 $44 - 4 - \Gamma\sqrt{4}$	64 $(4+4)(4+4)$	89 $4 \times (4! - \sqrt{4}) + \Gamma\sqrt{4}$
15 $4 \times 4 - 4 \div 4$	40 $44 - \sqrt{4} - \sqrt{4}$	65 $4 \times 4 \times 4 + \Gamma\sqrt{4}$	90 $4 \times 4! - 4 - \sqrt{4}$
16 $4 + 4 + 4 + 4$	41 $44 - 4 + \Gamma\sqrt{4}$	66 $4 \times 4 \times 4 + \sqrt{4}$	91 $4 \times 4! - 4 - \Gamma\sqrt{4}$
17 $4 \times 4 + 4 \div 4$	42 $44 - 4 + \sqrt{4}$	67 $44 + 4! - \Gamma\sqrt{4}$	92 $44 + 4! + 4!$
18 $4 \times 4 + 4 - \sqrt{4}$	43 $44 - 4 \div 4$	68 $4 \times 4 \times 4 + 4$	93 $4 \times 4! - 4 + \Gamma\sqrt{4}$
19 $4! - 4 - 4 \div 4$	44 $44 + 4 - 4$	69 $44 + 4! + \Gamma\sqrt{4}$	94 $4 \times 4! - 4 + \sqrt{4}$
20 $4(4 + 4 \div 4)$	45 $44 + 4 \div 4$	70 $4! + 4! + 4! - \sqrt{4}$	95 $4 \times 4! - 4 \div 4$
21 $4! - 4 + 4 \div 4$	46 $44 + 4 - \sqrt{4}$	71 $4! + 4! + 4! - \Gamma\sqrt{4}$	96 $4 \times 4! + 4 - 4$
22 $4 \times 4 + 4 + \sqrt{4}$	47 $4! + 4! - 4 \div 4$	72 $44 + 4! + 4$	97 $4 \times 4! + 4 \div 4$
23 $4! - \sqrt{4} + 4 \div 4$	48 $4(4 + 4 + 4)$	73 $4! + 4! + 4! + \Gamma\sqrt{4}$	98 $4 \times 4! + 4 - \sqrt{4}$
24 $4 \times 4 + 4 + 4$	49 $4! + 4! + 4 \div 4$	74 $4! + 4! + 4! + \sqrt{4}$	99 $4 \times 4! + 4 - \Gamma\sqrt{4}$
25 $4! + \Gamma\sqrt{4} + 4 - 4$	50 $44 + 4 + \sqrt{4}$	75 $(4 - \Gamma\sqrt{4})^4 - \Gamma 4$	100 $4 \times 4! + \sqrt{4} + \sqrt{4}$

This is an *old* problem. It was proposed in the *R.E. Journal* about 30 years ago by Capt. W. Turton, R.E. His solution was (I think) *incomplete*.

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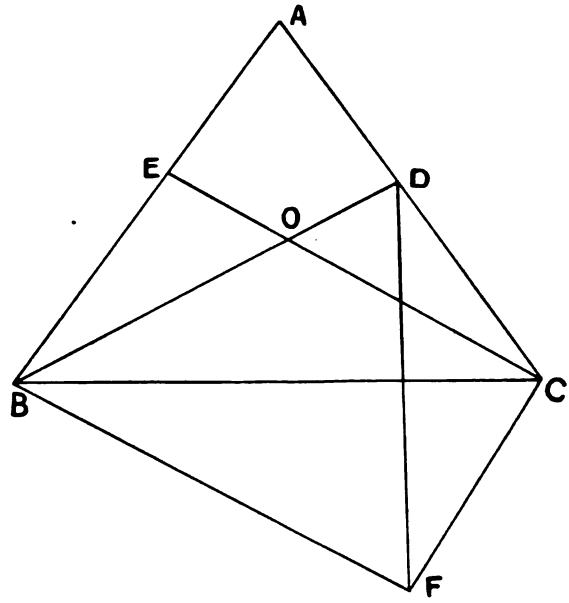
PROBLEMS.

PROBLEM 9 (Solution).

THE following solution has been received from a correspondent, who states that it was published in 1859.



BD and CE bisect the base angles and are equal:

Then the base angles ABC, ACB are equal.

Let BD and CE meet in O.

Suppose $\angle OBC > \angle OCB$.

Then in triangles EBC, DCB two sides are equal, but $\angle DBC > \angle ECB$.

$\therefore$ $CD > BE$.....(1) (Enc. I. 24).

On the other side of the base BC make $\triangle BCF = \triangle CBE$, and join DF.

Then since $BF = BD$,

$\therefore$ $\angle BFD = \angle BDF$ .....(2).

And in triangles DOC, EOB,

$\angle DOC = \angle EOC$, and $\angle OCD < \angle OBE$.

$\therefore$ $\angle ODC > \angle OEB$ (Enc. I. 32).

i.e., $\angle ODC > \angle BFC$.

Take away the equal angles (2) BDF, BFD.

Then $\angle FDC > \angle DFC$.

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$\therefore$ $CF > CD$ (Enc. I. 19),
i.e., $BE > CD$.

But by (1) $CD > BF$; which is absurd.

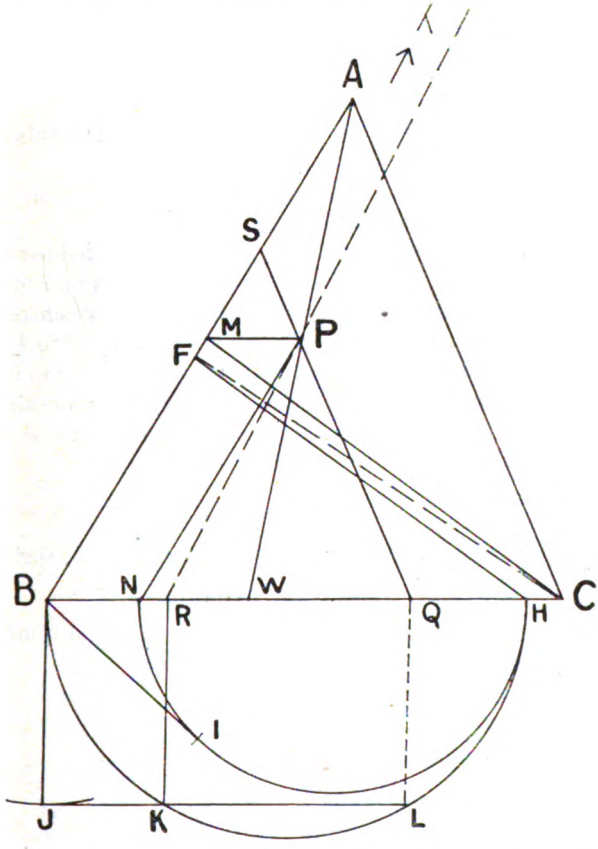
Therefore $\angle OBC \not> \angle OCB$, and similarly $\not< \angle OCB$.

$\therefore$ $\angle ABC = \angle ACB$.

Q.E.D.

PROBLEM 11 (Solution by Lt.-Col. Wade).

It is required to bisect $\triangle ABC$ by a line through P.



F is the centre of AB. Draw PM, PN $\parallel$ to CB, BA and FH $\parallel$ to CM, on BH, NH describe semicircles. Make KR, LQ equal to BI the tangent to inner semicircle from B. Join QP, RP cutting AB in S and T, it will be shown that $BSQ = \frac{1}{2}$ ABC, $BQ \cdot QH = LQ^2 = BI^2 = BN \cdot BH$.

$\therefore$ $\frac{BN}{BQ} = \frac{QH}{BH}$. $\therefore$ $\frac{BS \cdot BN}{BS \cdot BQ} = \frac{BM \cdot QH}{BM \cdot BH}$ .....A.

Then if $BS \cdot BN = \lambda\, BM \cdot QH$, then $BS \cdot BQ = \lambda\, BM \cdot BH$ .. ..B.

now $\frac{BN}{BQ} + \frac{BM}{BS} = I$

$\therefore$ $BN \cdot BS + BM \cdot BQ = BQ \cdot BS = \lambda\, BM \cdot BH$ .. ..C.

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But $BS.\ BN = \lambda\ BM.\ QH = \lambda\ BM\ (BH - BQ)$,

$\therefore$ $BS.\ BN + \lambda\ BM.\ BQ = \lambda\ BM.\ BH$ ....D.

$\therefore$ from C and D by subtraction

$$(\lambda - 1)\ BM.\ QB = 0.$$

$\therefore$ $$\lambda = 1$$

$\therefore$ by B $$BS.\ BQ = BM.\ BH$$ ....E.

and since HF CM are parallel

$$BM : BF = BC : BH.$$

$\therefore$ $$BM.\ BH = BF.\ BC.$$

$\therefore$ by E $$BS.\ BQ = BF.\ BC.$$

$\therefore$ $$\triangle SBQ = \triangle FBC = \tfrac{1}{2}\ ABC.$$

$\therefore$ provided S lies in AB and not in AB produced this construction solves the problem.

I cannot do more than indicate how to determine the positions of P which give possible solutions.

From elementary properties of the hyperbola 4 or 6 lines can be drawn through P touching 2 or 3 of the hyperbolas having a pair of AB, BC, CA as asymptotes and touching a pair of medians at their centres, these lines intercept with a pair of the sides of ABC an area equal to $\frac{1}{2}$ ABC, but by drawing the curves it will be seen that 3 lines at most can bisect ABC.

Other similar constructions to that given are obtainable by drawing PM, PN $\parallel$ to another pair of sides, and one or more of these constructions will give the possible solutions.

(Solution by Captain N. M. Vibart, D.S.O., M.C.).

Let ABC be the given $\triangle$ and P the given point.

The $\triangle$ when bisected will be divided into a $\triangle$ and a quadrilateral.

It appears that C will be the apex of the $\triangle$.

Bisect the $\angle$ ACB by CS.

Bisect the $\triangle$ABC by the median BM.

Draw BH perp^r to CS.

Determine N as shewn so that $CN^2 = CM.\ CH$.

Draw NK parallel to HB cutting CS at D.

Then $$\frac{\text{area } \triangle NKC}{\text{area } \triangle MBC} = \frac{\triangle NKC}{\triangle HBC}\ \frac{\triangle HBC}{\triangle MBC} = \frac{CN^2}{CH^2} \cdot \frac{CH}{CM} = \frac{CN^2}{CM.\ CH}$$

$\therefore$ $\triangle NKC = \triangle MBC$ in area for $CN^2 = CM.\ CH$ by constr.

$\therefore$ NK and MB are tangents to a hyperbola whose asymptotes are CA and CB.

CS is the axis of this hyperbola by symmetry, and D is its apex, for NK is a tangent at right angles to the axis.

Draw the auxiliary circle centre C and radius CD.

Let it cut the tangent MB at Y.

Draw YS perp^r to the tangent MB, meeting the axis CS at S.

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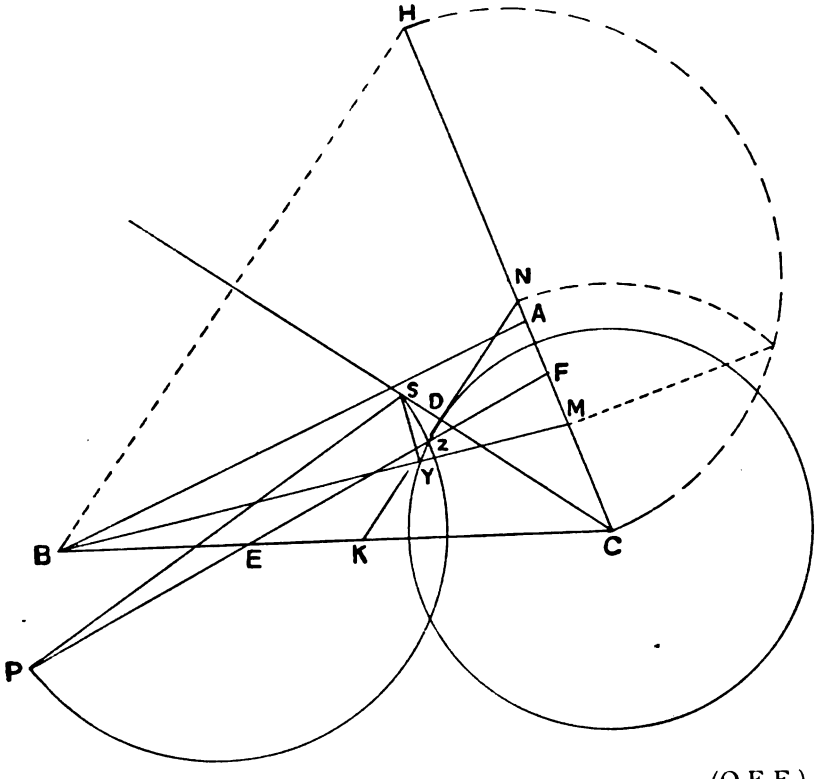
Then S is the focus from the properties of a hyperbola.
Join SP and describe a semicircle cutting the auxiliary circle at Z.
Join PZ cutting CA and CB at F and E.
Then SZ is at right angles to FE and Z is a point on auxiliary circle.
$\therefore$ FE is a tangent to the hyperbola.
$\therefore$ area $\triangle$FCE = the constant area = area $\triangle$MBC = $\frac{1}{2}\triangle$ABC.
$\therefore$ PEF is the required line bisecting the $\triangle$ABC.



(Q.E.F.).

PROBLEM 12 (Solution by Lt.-Col. A. J. C. Cunningham, late R.E.).

To find the remainder of 47^{7385} when divided by 17.
This is an elementary problem of congruences.

$47^{7385} \equiv (51-4)^{7385} \equiv -(2^2)^{7385} \pmod{17}$.

$\equiv -2^{14770} \quad \equiv -2^{8.1846+2}$,,

$\equiv -2^2 \quad \equiv -4 = +13$,,

Since $2^8 = +1 \pmod{17}$.

PROBLEM 15 (Capt. H. M. Johnstone, late R.E.).

Of all the pyramids standing on a given (scalene) triangle and having the same volume, which has the greatest inscribed sphere?

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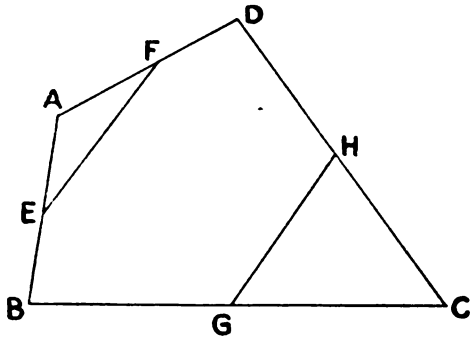
PROBLEM 16.



Four rods are freely jointed together at ABCD and lie on a smooth horizontal plane.

E, F, G, H are the centres of the rods, and the points E, F and G, H are joined by bars smoothly jointed at EFGH. If the system is in equilibrium and if the tension in EF is P, find the stress in GH.

J. M. WADE, *Lt.-Col.*

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TRANSPORTATION WITH THE B.E.F.

A lecture delivered at the United Service Institution of India, Simla, by Colonel the Hon. Sir S. D'A. CROOKSHANK, K.C.M.G., C.B., C.I.E., D.S.O., M.V.O. (*Published with kind permission of the U.S.I. of India*).

MY audience will no doubt realize that the subject of my lecture this afternoon on "Transportation with the B.E.F.," comprising as it does—

Organization and Administration,
Cross Channel Services,
Port Construction,
Dock Working,
Inland Water Transport and Traffic,
Standard and Metre-gauge Lines and Railway Traffic,
Light Railways,
Ropeways,
Roads and Road Transport,
Workshops,
Stores,
Accounting and Statistics,

is not only so vast, but also so replete with technical detail that it were impossible to deal with it at length in the short space of time at my disposal. I propose therefore to give only a brief descriptive review of the operations of the D.G.T. organization in France.

2.—In order to assist me in doing so, I would, at the expense of being sentimental, ask those present here who were with the B.E.F. to take themselves back for the time to France and bring to mind those four and a half years of relentless and intensive warfare, and those of you who were not so fortunate as to have had the opportunity of service with the B.E.F., to try and realize the severity of the conditions which obtained, and the onerous difficulties encountered in that hard-fought struggle.

Picture to yourselves the cold winds, rain, snow, and damp of the winter in Flanders, and the strenuous nature of the fighting under winter and summer conditions all along the British front throughout the whole period of the war. The strain on the troops engaged was no doubt relieved by many pleasant interludes and happy recollections of rest billets in the land of France, sunny as France can be, but although relief was possible to a certain extent for the fighting troops, there was little or no rest for the Transportation troops under the Director-General of Transportation.

3.—They had firstly to make up for lost time in building up the immediate transportation requirements of the army. They then had to keep pace with the rapidly increasing numbers and the enormous

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amount of materials which were being poured into France and sent up to the Front. Following this there came the period of intense pressure by which the enemy's line of resistence was eventually smashed, and finally, the severest test of all on transportation, the organization for the advance of practically the entire British army over the devastated zone from 30 to 50 miles deep (Arras to Mons) along the whole front, which had been scientifically and systematically demolished by an enemy who understood demolition and devastation to a nicety, and carried it out with the systematic practice and painstaking detail for which he had a justly high reputation. For the transportation troops this meant ceaseless work under high pressure and under great difficulties and discomfort. This was especially the case with the light railway men whose duties lay almost entirely within the shelled areas. Thus the tractor driver had to take up ammunition or supplies to his batteries or battalions on many a wild winter night, in inky darkness, under a heavy bombardment, over a road which had been trampled under foot into the mud. Their work was exceptionally heavy and extremely well carried out.

Other services like the Broad Gauge Construction and Operation, Roads and Quarrying, Docks and Inland Water Transport, Port Construction, Stores and Workshops, all had heavy leeway to make up and their task was more than fully cut out. Their splendid record was shared with the Labour Corps of various nationalities.

4.—I must, however, now proceed with the subject matter of my lecture. I think I am safe in saying, and I speak from personal experience as a Divisional C.R.E. at High Wood and Corps C.E. at Bouchavesnes, that in 1916 on the Somme the British Army was practically immobile. As you know, the pre-war arrangements for the B.E.F. in France were that with the exception, of course, of their own wheeled and motor road transport, and of a quota of R.T.O.'s, the traffic requirements of the British Army would be provided for by the French. It was very early seen that the French railways and French roads were not capable of maintaining the stress of war which was put on them, and little by little arrangements were being made by the Quartermaster-General's Department and the Royal Engineer Services to assist in railway construction and traffic and in road repairs and quarrying. In spite of the strenuous endeavours of stalwarts like Colonels Freeland, Murray, and Waghorn, the progress made was, owing to lack of supplies and administrative difficulties due to inexperience of warfare on this scale, wholly insufficient, and conditions were rapidly going from bad to worse. By the year 1916, the British Railway Companies had, however, commenced to carry out purely British Army works on a limited scale, but the transportation position on the railways and on the roads in the Somme forward areas was altogether inadequate, and it is probable that, had the Germans fallen back after the big British attack in September,

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1916, as they did in the early part of 1917, effective battle pursuit could not have been given. Light railways were in their infancy and only sufficient for purely local purposes.

5.—Realizing the position and foreseeing the difficulties that great leader, Sir Douglas Haig, had called in Sir Eric Geddes to investigate the transportation situation at large. The result was that the Director-General of Transportation's organization was formed as a separate entity towards the end of the year 1916. I daresay quite a number of you in my audience are asking themselves what exactly is a D.G.T. and what are his functions? He is not referred to in F.S.R., Part II., and where does he come into the military machinery? Why not have the ordinary directorships and departments under the Q.M.G. and let them rip on their own? My reply to all this is that the D.G.T. is to transportation men, machinery, and materials, what the Financial Adviser is to funds, and directly it becomes a matter of conservation of technical *personnel* and plant, and for the matter of that of unskilled labour also, a position which very rapidly arises, then central technical control over the technical directorates and departments becomes necessary in the shape of a Director-General of Transportation. Whether the D.G.T. is under the Q.M.G. or is an independent agency is neither here nor there. The General Staff plan the operations, the Q.M.G. lays down the requirements—the when and the where, the nature and the amount—and the D.G.T. does the collecting and forwarding agency. His *raison d'être* is a scientific combination of the various transportation resources with a minimum utilization of *personnel* and power. Thus in the case of the B.E.F., to serve as an illustration, it was seen that metre gauge railways and 40 c.m. tramways could be neglected. Docks would have to provide for berths, cranes, quayside railway facilities, transit sheds, electric and gravity runners, overhead conveyors, etc., for a possible 100 per cent. increase of imports. Light railways, by comparison with the French intensity of 12 to 14 kilometres per kilometre of front, for an 80 mile British front would require to organize for 800 route miles of line. The I.W.T. was to be supplemental to, and not in competition with, railways, and also in view of the demands for river craft for Mesopotamia it would suffice to limit their activities to 60,000 tons *per diem*. Railway Traffic had their objective in relieving the French of the whole of the British Standard Gauge traffic in Northern France, and Roads had their work cut out to do all the new construction and practically all the repairs of the roads in the British zone, finding their own materials, plant and machinery. However, to return to my subject, with the B.E.F. in France at any rate, the D.G.T. worked independently of, but hand in glove with, the Q.M.G., and in close co-ordination with the Headquarter Staff and Army Commanders, and with the G.O.C., L.O.C., and his commandants.

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6.—At its birth the organization consisted of Sir Eric Geddes as D.G.T., Sir Phillip Nash as Deputy D.G.T., and General Freeland and myself as the Forward Area Deputies. Subsequently, Sir Eric went to the Admiralty, Sir Phillip to Paris as Inspector-General of Transportation, and General Freeland to Mesopotamia and India. Directorates and departments were organized as I have already detailed, and by the spring of 1917 the baby was already a flourishing infant; by the end of the year, when handed over to me with Brigadier-Generals Brodie-Henderson, Hildyard, and Brough as my Deputies, it had grown to strength and vigorous manhood. In the army areas there were Deputy Assistants to the D.G.T. together with Traffic Officers, and the armies and corps also had light railway and road officers. Traffic demands were made on the Deputy Assistants to the D.G.T., who were in close touch with the D.G.T., H.Q., and the technical directorates. The Forward Deputies prepared schemes, made inspections and gave co-ordination.

7.—I will now briefly discuss the doings of each department of transportation, inflicting you, I fear, with a flood of figures, my excuse being that this is a lecture on a technical subject.

Organization and Administration.—Seeing that the D.G.T.'s organization was practically a new and separate branch of the Army which carried out its own recruitment, training and administration, and that at one time the technical *personnel* against an establishment of 365 units comprising 95,518 skilled troops, amounted to an actual strength of 83,600 technical men, with transport, to which were added 78,890 unskilled labour, making a matter of 162,500 men under the contro of the Director-General of Transportation, it will be seen that the demands on this department were very heavy. But mere numbers do not cover everything in dealing with the immensity of the transportation problems of the B.E.F., and never at any time during its 2½ years career did the D.G.T. possess a sufficiency of technical *personnel.* What our administration aimed at was to get and maintain a greater output from every unit, whether man or machine. These demands were, at the beginning, successfully dealt with by General Hardinge-Newman and later on by General Charteris, whose well-known pushfulness and zeal met with every success. This department, working in with the special depôt in England at Longmore, dealt with the D.G.T. *personnel* from the time of recruitment until the time of demobilization. It was in touch with, but independent of, the Accountant-General's branch, this being necessary because of the large number of technical men of various trades which were required in the different branches. The trades enlisted were in many cases quite outside the ordinary recognized trades for Royal Engineer Services, and it serves to illustrate the variety of trades to tell you of the diver recruit who, on reporting himself in France, was joyfully welcomed for underwater work, and on being asked what

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diving experience he had, stated that he was employed in that capacity at the Carlton Hotel! It transpired that he was the gentleman who dived for spoons and forks in the plate wash tub of that famous hotel restaurant.

The doings of the organization branch of the Director-General of Transportation are a lecture in themselves, as they comprise the organization of an entirely new branch of the army from its inception, and the development and maintenance of the same until the close of the operations, when D.G.T. was amalgamated with the Quarter-master-General's services. With the exception of the overseas railway troops all transportation troops were enlisted in the Corps of Royal Engineers.

8. *Cross Channel Services.*—The Naval Transport Service was represented at the D.G.T.'s headquarters by the Principal Naval Transport Officer, who with his Royal Navy district officers at the ports worked in with the D.G.T. Docks Directorate, with whom were also associated the Directorate of Inland Waters and Docks on the other side of the Channel. The features of the Cross Channel Service were the Cross Channel Barges and the Train Ferries.

The former was based on Richborough and the Thames, and went up into the canals on our side to the inland ports and depôts. The Cross Channel Barge Service, which in October, 1918, was handling a traffic of 25,000 tons a week, was also most useful in importing and evacuating stores and materials and was invaluable in releasing shipping.

The Train Ferry Service commenced in February, 1918, with three vessels intended to ply between Southampton and Richborough, and Dunkirk, Calais, and Dieppe. A fourth ferry boat was later on purchased from an American Lake Service for the Southampton-Cherbourg Service, but was found to be too top heavy for sea traffic, and was never usefully put into service. The advent of the Train Ferry Service made a marked advance in cross-channel transportation facilities in dealing with certain traffics. Each ferry was designed to take 52 standard guage 10-ton unit wagons, and the tying up and off-loading was completed in a matter of 15 minutes.

British wagons to loading gauge were thus run from collecting centres at home to depôts in France without unloading; the advantages of which in handling aeroplane parts and fragile stores, cranes, road rollers, artillery, and transport may well be imagined. But the greatest value of the service was in bringing over the railway locos. and wagons, the tanks on special tank wagons, and the rail-mounted guns. Hitherto, at great trouble and delay, these guns, of which there were no less than 84 with the British Army in France, had been landed from ship by crane, whereas now the gun in its travelling position was run aboard in England and run off in France straight to its destination. We were thus able to import guns like the Japanese

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14-inch, which weighed a matter of 296 tons and having an over-all length of 87 feet, without any craning and remounting, the difficulties attendant on which were enormous. For instance, just imagine having to handle a 90-ton barrel with our one and only 100-ton crane at the Bombay Dockyard at the end of a narrow jetty with turn-table manipulation. The vessels were decked to take mechanical transport wagons or loose horses if so desired. These ferries, which handled a to-and-fro tonnage of about 7,000 tons per week, were, when I left France in August last year, fully engaged in evacuating British rolling-stock and materials, and I contend that the service more than repaid the cost of the vessels and landing staging. It is possible to visualize very great use for these train ferries in India in Bombay Harbour and on the great inland waterways of Bengal, Assam and Burma. Both the Cross Channel Barge and the Train Ferry Services were run from home in combination with the D.G.T. organization.

9. *Port Construction.*—This Department was not called upon to carry out any extensive new works like the Americans had in constructing a new port on the Garonne, but they had a difficult and interesting job in the construction of the landing stages at Dunkirk, Calais, Dieppe, and Cherbourg for the train ferry termini. They also undertook the construction of railway facilities at quayside, and carried out hut and workshop construction. After the Germans had evacuated Ostend and Zeebrugge we sent some of our port construction engineers and skilled construction troops to help open up the docks and make a preliminary clean-up preparatory to handing over to the Admiralty and the Belgium authorities.

10. *Dock Working.*—The operations of the Docks Directorate under Brigadier-General Wedgwood, the brother of the well-known M.P., were very striking. The improvements effected in dock working were very far-reaching and we were able to raise the rate of discharge of ships from 12 to 34 tons per hour in port with an efficiency of 12 cwts. per man hour, and when, as was often the case, the D.G.T. organization was scoffed at on the score of expense, one was able to realize that the practical value of these figures applied over a week or so probably more than counterbalanced the whole cost of Geddesburg and its inmates. The ports operated were Dunkirk, Calais, and Boulogne in the north, and Dieppe, Le Havre, and Rouen in the south. Etaples, St. Valery, and Le Tréport were also used to a certain extent. The organization, handling the cranes, took over the import cargoes from the naval in-board service and passed them into depôt, barge or wagon according to circumstances. It made its own arrangements for cranes, conveyors, power and gravity runners, sheds, etc., and supervised the wharf labour handling the cargoes. The Docks Directorate also handled the export traffic which averaged 10,000 tons per week. It is interesting to note that the Americans

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made dock and depôt preparations for an import of 100,000 tons per day, but never actually reached that figure.

11. *Inland Water Transport and Traffic.*—The value of this Directorate, which conducted the barge services on the inland waterways of France and Flanders, was very great. At the end of 1918 the length of waterways operated was 474 miles, and our fleet consisted of 591 barges and 389 tugs, etc., or a total of just on 1,000 craft, and the organization was to take overside deliveries from ship to inland port, and again to move cargoes from inland depôt to the forward areas. The I.W.T. also operated on the Somme up to Amiens and Peronne, and on the Seine into Paris. Private civil canal traffic was controlled by them in co-ordination with an International Committee. This Directorate carried out very successful ambulance services for the evacuation of serious cot-cases from hospitals in the mid areas down to the base hospitals, and also moved sick horses for the Veterinary Service and sound horses for remounts in considerable numbers, and troops as required. On the Scarpe and Lys river canals the light craft were put to good use in handling materials and also the wounded by water in the battle areas. The tonnage handled by the I.W.T. in 1918 with a capacity of 130,000 D.W. tons averaged 60,000 tons per week. This Directorate, ably presided over by Brigadier-General Luck, late of the Royal Indian Marine, was also of great use in helping the Royal Engineer Services with their bridge construction work, and their assistance generally was much appreciated by the French, Belgians, and Americans. They built their own wharves and quays, and carried out their own repairs. Altogether a highly efficient and most useful branch of Transportation.

12. *Standard and Metre-gauge Lines and Railway Traffic.*—We now come to the construction, telegraph and telephone working, signalling, operation and traffic handling of the main lines. It is quite out of the question for me to deal here with this big subject, but to commence with I will give you in figures some idea of the extent of standard gauge line construction for the B.E.F. In 1914, 1·5 miles were laid; in 1915, 104 miles; in 1916, 417 miles; in 1917, 814 miles; and in 1918 and during the first two or three months of 1919, we put down 1,314 miles, making a total of 2,650 miles of new line. In addition, during 1918 and early 1919, 1,750 miles of track demolished by the retreating Germans were reconstructed, making a grand total in all of 4,400 miles of track opened to traffic.

The rate of construction in 1917 reached the very high figure of 6½ miles of new line per day, that is to say not mere track but formation, bridging, ballasting and track laying complete, and in 1918 we were reconstructing lines at the rate of over 20 miles a day. As an example of the work done by Colonel Lyell, the Chief Railway Construction Engineer, and the British Railway Companies, I may

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mention that, although Lille was only evacuated by the Germans on 17th October, 1918, they had by the 25th *idem* reconstructed the line from Bailleul across the trenches of both sides, built a temporary bridge over the Lys River and were able to run the first supply train for the relief of the civil populace into the city that day, opening a passenger service the following day. We used a certain amount of chaired track picked up from Home lines, but nearly all our lines were laid with a specially rolled 75lb. rail which gave great satisfaction.

The bridging operations were on an equally large scale, and 37,000 running feet of single track timber bridging were constructed by the railway troops.

8½ million tons of ballast were procured and laid on the formation, being 3½ times the amount of excavation for the Channel Tunnel from Dover to Marquise.

It may interest you to know that for the big attacks it was found that it was necessary to push forward standard gauge lines at intervals apart of about two miles; thus for the Messines-Wytchaete operations on an eight-mile front we had temporary forward lines on the Ypres-Roulers, Ooderdom-Dickebusch, Lindenhock, Douve Valley and Neuve Eglise alignments.

On the traffic and operating side the Railway Operating Division under Colonel Paget worked at one time 1,333 kilometres of line with 1,471 of their own locos and 70,346 10-ton unit imported wagons, the average haul being 60 kilometres with 33 wagon trains. On the metre gauge we operated up to 62 kilometres of line with 67 locos and 1,200 wagons imported. The minimum weekly average number of B.G. trains worked by the Traffic Department for the British Army amounted to 287 trains per day, and the *personnel* carried during August, 1918, averaged 350,000 all ranks per week. For the evacuation of the sick and wounded, we had in use 40 ambulance trains and for leave men we ran a dozen rakes of made-up "Noah's Ark" stock.

Troop movements were worked to the scale of one train per three hours at each of three stations, making 24 trains per 24 hours maximum. The capacity of single lines with passing stations about two miles apart was 16 to 24 trains per day each way, according to the terminal facilities. On the Bergues-Proven double line which we opened for the Passchendaele operations we operated up to 56 trains per day each way, but here we experienced great difficulties with the sand ballast, as the Flanders slush working into the ballast flooded the sleepers. It will perhaps convey some idea of the traffic handled to state that in the bombardments in the major operations 40 broad gauge train loads of ammunition per day were often fired from the gun, which worked out in some cases to 1½ tons of metal per day per yard of front attacked. The all-in allowance for Divisions in the

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fighting line averaged nearly 2½ trains per Division per day, the pack trains carrying the daily supplies at the rate of two Divisions per train. The big ammunition depôts were worked entirely by our R.O.D., the layout of that at Dannes Camiers near Boulogne, for instance, having a 75,000 tons capacity and 45 miles of B.G. line, and great credit is due to General V. Murray, Colonels Magniac, Russell, and Birney and the staff of the Traffic Directorate for their successful handling of the heavy traffic of the B.E.F. under very difficult conditions.

13. *Light Railways.*—But the greatest progress in any branch of transportation was made by the Light Railways Directorate under General Harrison of the Argentine Railways.

In early 1916, although the Germans and French armies were by then working extensive light railways systems along their fronts, the British Army had only made a commencement with a small system operated by Captain Delphine, under General Nanton, at St. Eloi, alongside of which in my Division, the 47th (London)—the foundation of whose great successes in the war, I may mention, was due to the training and instruction given in its earlier incarnation by its late commander, His Excellency, our present Commander-in-Chief in India—we were putting down the Carency, Souchez, Zouave Valley system to feed our front line on the Vimy Ridge. So that General Harrison practically struck out on a new line with a clear field. Beginning in January, 1917, with a tonnage carriage of 10,000 tons per week he had for the Messines operations in July of the same year reached 180,000 tons per week, and by March, 1918, the tonnage on light railways had amounted to no less than 280,000 tons of all traffics per week. The German offensives of the 21st March and 9th April brought this down to 120,000 tons per week, after which it again fell to the salvage and evacuation level of 40,000 tons per week.

I could yarn quite a lot on light railways, but I must content myself with giving a few figures of interest derived from actual experience.

All our light railway lines were on the 60c.m. (1ft. 11½in.) gauge and we had no use for the 40c.m. tramway track extensively used by the French. We had a 20lb. section by 5 metres rail, but recommended a 25lb. section to the Americans, who adopted it and, I understood, found it satisfactory. Besides the 20lb. rail we imported and supplied 8 and 16lb. track for tramway and R.E. Services. The locos were Baldwin and Hunslet 4/6/0, and American 2/6/2 and the tractors mostly 20 and 40 H.P. Simplex and 45 H.P. Petrol Electric, and all manner of wagons from 10-ton bogies down to 3½-ton open wagons. Even smaller units were used, or obtained for the R.E. Services. On active fronts we put down an average of 10 kilometres of track per kilometre of front. On less intensive fronts the ratio was as 6 to 1.

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Light Railways operated at times over 1,000 route miles of line, and they laid some 3,000 miles of track during the two years of their existence. The rolling-stock on charge was 640 locos, 875 tractors, and 5,918 wagons. These figures give a close comparison with those for the whole of the 2ft. 6in. and 2ft. 0in. gauge systems in India taken together.

The traffic on each light railway system along our front was controlled from the local headquarters of the Assistant Director of Light Railways with each army, who kept card index logs of each loco and wagon, controlled the traffic and checked by selector telephone.

Corps systems were designed to take up to 3,000 tons per day with 80-ton load trains on a maximum 2 per cent. grade and 30-metre curve, but the corps traffic offered rarely ran to more than 1,600 tons *per diem*, the balance being available for railway ballast and material. For the advance of the 5th Army in the Passchendaele operations arrangements were made to run forward a separate light railway line for each corps at a rate of advance of two miles per day. A great feature of our light railways was that we used them to carry traffic of all natures, for moving field guns and howitzers along the front, and also extensively for gas projector attacks. They were of immense value in transporting working parties as well as fighting units up to the front, to save them the long march over crowded roads and tracks under shell-fire. As many as two hundred thousand men were transported thus per week, and the forward ammunition traffic often rose to 50,000 tons per week. The light railways also carried wounded and water in special wagons, and ran completely fitted up repair trains. Breaking load for transhipment from S.G. to L.R. was effected on the average :

Ammunition at 7 miles from the front line.

Stores 6 miles.

Stone, planks, etc., 4 miles.

Independent hospital or forest systems were based on a minimum traffic of 400 tons per *diem*, and the maximum lead for satisfactory working was found to be about 12 miles. The losses in rolling stock as a result of the German advance in 1918 were about 400 power units and a couple of thousand wagons. These losses were inevitable, as at Amiens the Germans overran the whole light railway system *en bloc*, in spite of the fact that special run-back lines had been provided at intervals behind our line in anticipation of a set-back at any portion of it. All losses were, however, made good during our advance, during which the German L.R. stock was also captured.

14. *Ropeways.*—Those being brought into use in France towards the end of the war were the Hamilton and Leeming ropeways. The former has an average capacity of 20 to 25 tons per hour, and is worked by a 25 H.P. petrol engine. The rope speed would be about four miles per hour, with a maximum single load of 300lbs. and a

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point-to-point gradient of 6 per cent. The Leeming ropeway is a lighter plant of about 15 tons per hour capacity. It has the advantage for forward area purposes of facility in being lowered to lie flat on the ground to escape observation by day, but this plant is not sectionalized like the Hamilton.

Although ropeways were in extensive use in Italy during the war, they were only just coming into use in 1918 for British front line transport in France by the newly-organized "Forward Transportation" Companies which were destined to work the tramways, ropeways, etc., in the Brigade forward areas ahead of the main D.G.T. Organization to a traffic of about 600 tons per corps *per diem* for 16 Corps.

15. *Roads.*—The B.E.F. was severly handicapped by the loss of the famous Quenast quarries near Brussels, held possession of by the Germans, which supplied the granite setts and superior macadam to Western Europe generally, and I believe also to Kent and other English counties. We had to depend for our road metal on the output of stone of average quality from the Marquise quarries near Calais and from quarries in Basse Normandie, together with superior granite imported from the Channel Islands and iron slag from Middlesbrough. Concrete ballast supplied to the R.E. Services was obtained from the gravel beds at Aire and elsewhere, and mine earth for standings from the coal pit heaps.

To give you an idea of the magnitude of the operations of the D.G.T. Roads Directorate, organized and controlled by Brigadier-General Maybury of the Road Board, I may mention that the stone utilized equalled that required for a road 12 feet wide by 12 inches thick, being the like of a first class Indian Provincial road, 1,997 miles in length, and the timber used in road construction, that is to say, the sleepers and 3-inch beech planks laid in timber roads, would have made a 9-foot wide road 374 miles long.

The Director of Roads obtained altogether 166,600 tons of granite from the Channel Islands, and 216,000 tons of slag from Middlesbrough, before shipping difficulties prevented further importation of these valuable road metals. He took three million tons of stone from the Marquise quarries, a fine performance on the part of the Quarry Companies and German prisoners, and at the rate of 4,750 tons per week from the quarries in the south.

At times we used to take 20 full train-loads of stone from Marquise every day, and even then we were not able to fully satisfy the requirements. For transport, quite apart from the army motor and wagon transport supplied on daily requsition, we had 1,066 lorries, mostly of the 5-ton Steam Foden Tip type which were found to be particularly useful. We also had a matter of 930 special American dump carts for distribution of metal along the road. This is a very handy material cart having a drop floor and a good lock. The tarring

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operations which were carried out during the summer months gave a splendid travelling surface, and practically did away with the dust nuisance on the main roads, on advance roads under distant observation, and in and around hospitals and depôts. Practically the whole of the road *personnel* was obtained from England, and when one comes to think what a Herculean task it was to maintain the existing roads and to make roads through the mud of Flanders and across the trench zone, one can understand the difficulties which this Directorate had to contend with, and appreciate the successes which they obtained. Towards the end of the war the D.G.T. Roads Directorate was maintaining a total length of 4,412 miles of road.

16. *Workshops.*—Besides departmental local shops for running repairs we had main workshops at Andruicq (near Calais), Rang du Fliers and at St. Etienne (near Rouen), which latter shops were ably managed by Colonel Cole, now Secretaty to the Indian Railway Board, for main line stock, and at Berguette and later Beaurainville for light railway and road stock. Engine and wagon erection and heavy repairs of all sorts were carried out at these shops, so that the task imposed on Colonel Simpson and the mechanical engineers was a very big one. We were also greatly assisted in our heavy repairs by the South Eastern and Chatham Railway.

17. *Stores.*—The main depôts were at Andruicq in the north and at Oissel in the south, with expense depôts and dumps in the army areas. However good the organization of the Transportation Departments everything depended on the regular and sufficient supply of stores of all sorts and kinds, and the management of this very important department gave great credit to Colonel Kellner of the Indian Railway Audit Department who was in charge.

I may remark that the Andruicq depôts and shops covered an area of over 700 acres laid with 70 miles of S.G. track, and that we aimed at maintaining for an advance through Belgium a reserve stock of 700 miles of B.G. rails, fastenings and sleepers at this depôt.

18. *Accounting and Statistics.*—I will refrain from expatiating on the doings of this branch by whom an accurate record was kept in simple business-like form of all financial transactions and store-keeping. The Railway Accountants section was a particularly heavy one in keeping tally of haulage, loco and wagon hire, and such like exchange charges, and on the closing down of D.G.T. last year a complete debit and credit account running into millions was given in to the War Office for adjustment in the national settlements. Throughout the operations weekly reports of the transportation position and of the traffic of all natures handled were submitted punctually to G.H.Q., to armies and to the War Office. A summary was prepared quarterly, and at the close of the year a review was issued which briefly covered the whole working of the several branches of the D.G.T. organization. But special value was

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attached to the upkeep of graphs illustrating the progress made and traffic handled. By this means an immediate working check was maintained and an accurate record kept, and one was able to see at a glance the tonnage discharge per hour in port at each port, or the coal consumption per loco kilometre or petrol per tractor mile week by week. In the portfolio of 23 plates there exists a complete record of the D.G.T. work which can be seen at a glance and studied throughout in half an hour. We attached a very high importance to statistical graph keeping and secured very great advantages in economic working and good record therefrom.

19.—Time does not permit me to go into the actual working of the D.G.T. organization, but I may perhaps mention that for the Somme, Arras and Messines operations we put down 55, 65 and 90 miles respectively of new broad gauge line. At Cambrai in November, 1917, we had an interesting job in bringing up, under conditions of extreme secrecy, the 350 or so tanks which took part in the surprise attack.

Great anxiety was felt in the critical transportation situation which arose as the result of the enemy's advance in 1918 on the Somme and Lys as thereby our extremely important forward lateral, St. Omer, Hazebrouck, Lillers, Bethune, St. Pol, Doullens, and Amiens for Paris came within the range of his guns. We were thus driven back on to the Calais, Boulogne, Etaples, Abbeville coast line with weak forward lines and poor railheads. Quickly seeing this, the German airmen set out to bomb the vital points causing serious damage in Abbeville, Boulogne, and Calais. But his main aerial attack was directed at the railway bridge over the Conche River and the station at Etaples. Realizing the importance of this bridge, we had set about to lay a diversion line and it then became a keen contest whether he cut the old line or we opened the new line first. Eventually he got a direct hit on the track and blew in one span of the bridge at the same time causing great damage and heavy casualties at, and around, the station, but his supreme effort to interrupt communication between North and South was by great good luck foiled, as the diversion line which we were building, and we had to go over a mile upstream to get a good temporary bridge crossing, had fortunately been opened the day before and we were able to pass without delay a heavy French troop move in reinforcement of the Mount Kemmel operations. This incident was therefore a matter of satisfaction to all alike, French, Bosch, and British. In anticipation of aerial bombardment we had also steel decked and timber centred the railway viaduct at Wimereux, but this target escaped attack.

20.—Before concluding my lecture I must take the opportunity of rendering a tribute to the Engineers of all sorts and ranks from nearly every part of the globe who served in the D.G.T. Organization. These Engineers differed widely. The Home Engineers, highly

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technical and skilled, but at first lacking adaptability. The 14 battalions of Canadian Railway Troops under General Stewart, self-reliant and resourceful to a degree, and invaluable in the construction of standard and light railways and timber bridges. The rapidity with which they worked was little short of marvellous, being greatly facilitated by an extensive knowledge and use of labour-saving devices in the shape of mule hauled scrapers for making banks and cuttings, the 2-ton Marion steam shovel which eats into hard chalk like sand and fills a muck train in 15 to 20 minutes, the plough wound by the engine which clears the said train from end to end in one haul, followed by the engine plough which clears and levels the spoil from the side of the track. These and other devices more than proved their value. Three battalions of U.S. Engineers under General Harts, and the operating companies lent by General Atterbury, the American D.G.T., were thoroughly representative of the go-ahead American Expeditionary Force under the command of their magnificent leader—General Pershing. The Portuguese Railway Troops not only worked well, but stood up satisfactorily to shell-fire. The Australians, New Zealanders and South African railway men also put in splendid work of great value to the B.E.F. Perhaps the best all-round individual Engineers were the home men who had colonial experience, but the Indian Engineers, Royal and Civil, with good qualifications, considerable practical experience and administrative ability, held their own easily, and were in fact the foundation and backbone of the whole D.G.T. organization administration. The Belgians loaned us barges and engines, and helped as far as possible in their power. But the heaviest strain fell on the French railway organization, who had made the mistake, which we did ourselves in the earlier days, to send too many of their younger technical men into the firing line, consequently their railway men soon became worked out and it was only due to the pushfulness and resource of their transportation Chiefs, Colonels Payot and Boquet, and men like Colonel Dumont and Monsieur Javary of the Nord Railway, that they were able to carry on. Their wagon control was unfortunately very weak and our efforts to induce them to organize it on sound lines in co-ordination with our B.O.D. wagon control were unavailable. Consequently there was considerable wagon wastage and great difficulty in adjusting the traffic requirements at the different centres. However, all is well that ends well.

21.—The D.G.T. organization was subjected to non-professional criticism in connection with its arrangements for following up the general advance in the latter part of 1918, but the layman cannot possibly conceive the enormous difficulties which confronted transportation at this stage and throughout the winter of 1918-19. The men, mostly of advanced years, the glamour gone and peace in sight were absolutely worn out, and they wanted to return to their

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families and civil occupation. The demands were exceptionally heavy, and it was only with the greatest difficulty by ruthlessly shutting down light railways and other services, and sacrificing everything to the construction of roads and main lines and handling the traffic, that we were able to carry on at all.

22.—My request to the General Headquarters that only contract and police troops should be pushed forward over the devasted zone was deemed impracticable and the best part of five British armies and the cavalry took up the advance into Belgium. As may be imagined, the transportation position became acute, but we have this to our credit that I believe only on few occasions did the advance troops find it necessary to requisition on the countryside for supplies. The French on our right and following in our wake under more favourable conditions, progressed but slowly, and the Americans at the pivot end of the line and on a much smaller scale were, I was given to understand, on the verge of starvation. Our difficulties were increased by the severity of the winter season on the destroyed communications, and by the large number of delay-action mines which the enemy had buried in the main lines. These mines were sometimes double action, and set over a period of four months or more, but the chief difficulties in maintaining main line traffic were in the lack of telegraphic and telephonic communications, signalling facilities and engine water supplies, which had been systematically destroyed right into Belgium, making intensive traffic working on the scale then demanded a super-human task. One of our chief difficulties at this stage was that the French and Belgians barged in with heavy civil traffic on the temporary lines which for political reasons the allied military authorities had to give in to. It will be seen that the layman was probably not in the know of all the facts on which to frame a fully considered opinion.

23.—However, troubles in plenty there were on every side, and D.G.T. was an endless struggle with the deficiencies of the past, the detection of mistakes at the time and the provision for the possibilities of the future. I was always at great pains to illustrate our mistakes to my numerous visitors at D.G.T. That this had its value was brought home to me by the remark made by an American Transportation officer who came to study our methods. After showing him round and telling what we had done and where we had gone wrong, on his departure with delightful candour he said: "Say General"—and I was a General in those days—"Say General, I have to thank you for your hospitality and the highly interesting and instructive time you have given me. I can say this that I have profited quite a lot by your mistakes." And, for the matter of that, in the preparation of this lecture for the most part by drawing on my memory I cannot claim exemption from inaccuracies.

24.—The wind-up of Transportation with the B.E.F. was that

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the whole outfit of track on the ground, plant and machinery, craft and rolling stock was taken over by the Disposals Board. By that time the Army of Occupation on the Rhine was being maintained by Rhine barges *viâ* Rotterdam, ordinary train service *viâ* Antwerp and a fast leave and staff service *viâ* Boulogne on which we used converted Ambulance trains as sleepers. This daily passenger train was facetiously called the "B.C." Express, although we ultimately got it to run through from Boulogne to Cologne in 16 hours, which was not bad going. The evacuation of locos, wagons, motor transport vehicles, horses and carts, etc., was being carried out by Cross-Channel services to Richborough; and fixtures such as hutting, shops, etc., were sold off by auction as they stood on the ground. I need go no further.

I fear I have rather overwhelmed you with facts and figures, which I have given you, not in any way in glorification of "Transportation with the B.E.F.," as might appear to be the case, since it were superfluous to extol that wonderful organizer and great leader and driver, Sir Eric Geddes, and the splendid efforts of all ranks of D.G.T. speak for themselves, but for their practical value and in order to show what the transportation requirements of a big war actually amount to, if only as an object lesson and a study.

Transportation in France has, I claim, a great past, on the other hand transportation in India has, I maintain, an immense future. One has only to step outside to see how backward we are here in Simla with lifts, ropeways and such like local transportation facilities, and to look at the map of India with the country cut up into strips by the great rivers, and only as many ports as can be counted on the fingers of one hand, ill-connected by railway at that, to realize the situation and the importance of studying transportation closely in all its branches balancing its possibilities and improving it in all directions.

Sir George Buchanan has done good service to draw attention to our ports, and Lord Montagu of Beaulieu, Mr. Dorman and other writers to our roads. There is surely every reason to encourage more transportation by our inland waterways. However, these are matters for the General Staff and for the talked-of Transportation Department, and not the theme of my lecture, which I must now bring to a close.

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THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914–1919.

REFERENCE has been made from time to time in *The Royal Engineers Journal* to the official war records which were in course of preparation, and portions of which have already been printed in the *Journal*. A proposed synopsis of the whole work was published in the *Journal* for September, 1919.* At the time when this synopsis was first drawn up it was supposed that these records would be published by His Majesty's Stationery Office at public expense. For various reasons this has not proved feasible and, as agreed at the last Annual Corps Meeting and announced in the July, 1920, number of the *Journal*, the first cost of publication will be borne by Royal Engineer Library funds, and the enterprise therefore becomes financially a private one on the part of the Officers of the Corps. For this reason a more detailed account seems rightly due of the work that has both been done and left undone. Before going on to this account it is as well to make it quite clear that the available funds will only cover the cost of production of a very few volumes ; and upon receipts from sales of the first volumes will depend the issue of further parts.

*The proposed synopsis was as follows:—

Part I.—General. Development of the Corps. Causes that led to the formation of new branches and units. Charts to show organization and strength of the Corps in August, 1914, and Nov., 1918, etc., etc.

Part II.—Work under the Director of Fortifications and Works.

Part III.—Work in the Field under the Engineer-in-Chief, B.E.F.

Section 1. General.
,, 2. Engineer Intelligence.
,, 3. Defences.
,, 4. Bridging.
,, 5. Water Supply.
,, 6. Machinery, Workshops, Electricity.
,, 7. Mining.
,, 8. Geology.
Section 9. Inundations.
,, 10. Camouflage.
,, 11. Anti-Aircraft Searchlights.
,, 12. Foreways.
,, 13. Concrete Factories and Defences.
,, 14. Experimental Section.
,, 15. Hutting and Encampments.
,, 16. Schools.

Part IV.—Work in the Field under other Branches of the Staff (France).

Section 1. Maps.
,, 2. Gas Services.
,, 3. Forestry.
Section 4. Postal Section.
,, 5. Meteorological.

Part V.—Work in the Field in other Theatres of War.

Section 1. Egypt.
,, 2. Gallipoli.
,, 3. Mesopotamia.
,, 4. Salonika.
Section 5. W. Africa.
,, 6. E. Africa.
,, 7. Miscellaneous.

Part VI.—Work under the Director of Works (France).

Part VII.—Work under the Director-General of Transportation.

Part VIII.—Supply of Engineer Stores and Material.

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Many of the subjects must have a wide field of interest in the Civil Engineering world, and, to a much more limited extent among the general public ; but the problem is how to explore these fields. The cost of advertisement on a large scale is entirely prohibitive, and the problem is not an easy one. Any solutions will be gratefully welcomed, but meanwhile it is evident that a good deal can be done individually in bringing the books to the notice of anyone who might be interested, but who would not in the ordinary course see *The Royal Engineers Journal.*

The general object of these books is to present a simple record of the military engineering activities of the War, which may serve not only as a reminder of what has actually been done, but as a guide for future generations to what they may have to do in other wars. On most subjects the information has been plentiful and the difficulty has been rather one of omission than of collation. In deciding what to include, the criterion has been general and permanent as opposed to personal and fleeting interest. No attempt has been made to record the full activities of formations or units, nor would it have been possible within the scope and time of this work ; and so individual actors in the great drama may look in vain for accounts of many of their most cherished scenes and triumphs.

The actual synopsis more or less explains itself. Each technical subject clearly had to be treated separately, the principal question being whether work in all the theatres of war should be included in each technical volume. This was ruled out for several reasons, the deciding factor being that full records were available from France much sooner than from distant theatres, and to await these would have caused a delay of many valuable months. The intention was to compile one complete volume for each minor theatre of war ; actually records are in most cases still far from complete, and, as it has been found necessary to finish off the present work before the end of September, these volumes have perforce been abandoned.

Possibly volunteers may be forthcoming to complete the work later on ; meanwhile the available records have been placed in the Royal Engineers Library, Horse Guards, where they may be studied at any time. There is one important exception. The Water Supply operations in Egypt and Palestine, one of the most interesting exploits of the whole war, have fortunately been fully recorded, and a slightly condensed version of the official report has been prepared for publication among the first volumes that will be issued.

To revert to the original synopsis : Part I. "General" and Part II. "Work under the D.F.W." have not been proceeded with separately, but the work of the F.W.5, F.W.8 and F.W.9 branches is included in Part VIII., "Supply of Engineer Stores and Material." This Part is ready for publication, and, in view of the importance of the subject, it is hoped to issue it as a separate volume at an early date.

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As will be seen from the table appended to this article all the sections of Part III., "Work under the Engineer-in-Chief, B.E.F.," are ready with three exceptions :—Section 1, "General," would have been mainly recapitulation and has been abandoned† ; so has Section 15, "Hutting and Encampments," which is fully dealt with in the history of the Works Directorate (Part VI.). There was a certain amount of additional material in the shape of plates showing type buildings and lay-outs from various Armies, and these have been sent to the Construction School, S.M.E. The third exception, Section 3, "Defences," needs more explanation. The fact that a volume on this subject was not among the first for publication has already aroused comment and criticism, and that no volume at all on the subject should be proposed will no doubt arouse still more. But a very little thought will disclose some of the difficulties of the task, difficulties that on closer examination have appeared to the writer to be insuperable. To begin with defence works are by no means the preserve of the Royal Engineers. The General Staff is mainly responsible for "Siting," whilst R.A. and machine-gunners are at least equally implicated with the Royal Engineer. "Execution" of work is to a great extent in the hands of other branches than Royal Engineers, a point that is apt to be overlooked, with the result that execution and responsibility become divorced. "Design" is certainly the business of the Royal Engineer, but here there can be no finality, nor could the subject be treated separately. Emerson says " . . . . it is as difficult to appropriate the thoughts of others as it is to invent," which may account for the embarrassing variety of design that was always to be found in all defence work. "Defences" have to be standardized for the Army in the same way as "Stores" and "Equipment." That is to say, that the most suitable types for general use are selected as the result of prolonged study and test by a Committee, and are finally described in an official handbook, training manual, or vocabulary, as the case may be. But woe to the historian who tries to relate in official form the work of defences in the Great War. Shortly, it cannot be done. Defence work consists principally in applying a few fixed principles to innumerable changing conditions, and the ways in which this may be done are infinite. And so an infinite number of volumes might be written on the subject ; each one of them representing the views of one individual, which would never be quite the same as those of any other. No subject is more full of possibilities or gives a wider scope to a writer, and it is to be hoped that not one but many unofficial books may be produced in time. Anyone who wants some preliminary practice might do worse than try his hand at writing a

†For a General Survey see Major-General Sir G. M. Heath's lecture before the Institute of Civil Engineers.

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sequel to Ch. XI. of General Thuillier's *Principles of Land Defence*.‡ Those who have read this book will remember that the first half of it is devoted to a study of the development of fortification from the earliest ages in accordance with fundamental principles. A sequel covering the period 1914–1919 would supply a fascinating page of history. One might go further and suggest that an essay on these lines by students at the end of every Military Engineering course would provide a better test of the value of the course to the students than any number of ordinary examination papers. But this is a digression. Reports are in existence of the organization of Rear Zone Defences in France in 1914–15, and again in 1918 under the Engineer-in-Chief, and it is hoped to publish these shortly in the *R.E. Journal*.

Part IV.—"Work under other branches of the Staff (France)" is complete. Sections 2, 3, 4, and 5 have all been published in *The R.E. Journal*, whilst Sect. 1, "Maps," has been written and is being issued separately under the General Staff.

Part V. has been dealt with already. Part VI., "Work under the Director of Works (France)" is ready for publication.

Part VII, "Work under the Director-General of Transportation," is understood to be in preparation, but it is not known when or how the records will be published. Most branches of Transportation are concerned with essentially Engineer services, and the special conditions that produced a separate organization in France are referred to more than once in the R.E. records. In the more distant Expeditionary Forces transportation (or communication) services formed, as has always been the case, a large part of the work of the Royal Engineers, and this was an added difficulty in the way of combining all theatres of war in the same volumes.

Finally, a word must be said about "Signals." Although the Signal Service has become partially independent it was throughout the War an integral part of the Corps of R.E., and no account of R.E. work in the War is therefore complete without some reference to "Signals." In the volume entitled "Supply of Engineer Stores and Material" much space is devoted to Signal stores, but Signal work comes in a category of its own and its history can only be written by members of the Signal Service.

To complete this short summary, a list is appended of the various manuscripts and files that have been placed in the R.E. Library and elsewhere, and another of the volumes that have been actually completed for publication.

It has been impossible to prepare these records without becoming more than ever deeply impressed by the remarkable range and

‡*The Principles of Land Defence*, by Captain H. F. Thuillier, Royal Engineers. Longmans & Co., 1902.

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variety of occupation that fall to the lot of the Royal Engineer; so remarkable indeed that there can surely be no other body of men in the world who have an equal scope of employment and interest. And yet science, and especially the application of scientific methods to war, which is the special province of the Military Engineer, is still in its infancy; so that however great the interests of the past they are overshadowed by the possibilities of the future. The aftermath of war always brings its changes and controversies, and the present is no exception; but he must be a sad pessimist who cannot see the sun shining through summer mists. That some such impression may also remain with readers is the earnest wish of

THE AUTHOR.

LIST OF MANUSCRIPTS, FILES, ETC., AND HOW DISPOSED OF.

To R.E. Library, Horse Guards.

All reports on R.E. work from theatres of war other than France and Flanders.

Complete (nearly) set of E. in C. (France) Field Works Notes.
" " " " " Field Fortification Plates.
" " " " " German Field Works Plates.
" " " " " D.P. Plates (hutting, etc.).
Original (Typescript) report on Mine Rescue Work, by Lieut.-Col. Dale Logan.
" " " by C.E., Second Army (France).
" " " " Fourth " (").
" " " " Fifth " (").
" " " " London District (Col. Russell).
Foreways: original report, plates and G.H.Q. correspondence.
Various reports by C.E.'s and C.R.E.'s on tactical employment of R.E. Units (France).

To S.M.E., Chatham.

Fortification School—Various defence plans, bridging photos, etc.
Construction School—Hutting, etc., notes and plates.
Workshops—Plates of Army Workshops productions.

To D.F.W.

Complete original report by Director of Works, France (without plates).

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LIST OF VOLUMES PREPARED FOR PUBLICATION.

|| "Bridging," with about 50 plates and maps.
"Water Supply," ,, 60 ,, ,, ,,
"Water Supply, Egypt and Palestine," with about 23 plates and maps.
Mining, historical, etc., with about 34 plates and maps.
,, technical, with about 67 plates and maps.
Experimental Section with about 65 plates and maps.
Geology with about 20 plates and maps.
Works Directorate (France)—letterpress only.
,, ,, —91 plates only.
Supply of Engineer Stores and Material with 1 plate.

(The following sections are ready, but their exact composition into volumes is not settled).

Camouflage with about 22 plates.
Workshops, Machinery and Electricity with about 25 plates.
Concrete Defences and Factories with about 21 plates.
Forward Communications with about 29 plates.
R.E. Schools with about 10 plates.
Inundations with about 9 plates.
Chemical Warfare with about 5 plates.
|| A.A. Searchlights.
|| R.E. Intelligence.
|| Forestry.
|| Postal Section.
|| Meteorological Section with about 12 plates.

|| These sections have already appeared in the *R.E. Journal*.

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*THE ARMY QUARTERLY.**

By BRIG.-GENL. J. E. EDMONDS, C.B., C.M.G.

THE British Army, not having Bolshevist funds at its disposal to finance it, has long lacked a literary organ. No army requires one more. First, to keep in touch with military thought and literature its regular members who are flung wide over the globe guarding the Empire, and its Territorial members who can only give part of their time to military study. Secondly, to bring to the notice of the general public, who give neither whole nor part time to military service in peace, something of the military art and of the problems and difficulties that beset soldiers, so that the army in its preparation for war, may receive at least the moral support of the nation.

The *Journal of the United Service Institution* and of its brother in India, the *Cavalry Journal*, the *Journal of the Royal Artillery* and the *Royal Engineers Journal* are not to be seen on bookstalls; they appeal to the professional reader only.

In April, 1907, an attempt to start a military magazine officially was made in a humble way with a little periodical called "Recent Publications of Military Interest." At first it contained only reviews of books, etc., then short articles and translations were added; and in July, 1911, it developed into the *Army Journal*. I notice that a writer of reminiscences has claimed credit for all this, but actually—I speak from first-hand knowledge—he was not even consulted; it was due to Colonel (now Lieut.-General Sir Aylmer) Haldane. The *Army Journal* continued to appear until the beginning of the war. Its last number is dated July, 1914. The last but one significantly contained an article on the "Causes of the Downfall of Prussia in 1805."

There are, however, obvious objections to official journalism, so that instead of reviving the *Army Journal* it has been left to the private enterprise of Messrs. Clowes and Sons to produce an *Army Quarterly* in the red cover and with the general form of the earlier official publication.

It is to be hoped that it will be well supported. I am not one of those who desire to turn the British officer into a bookworm, he would not be the wonderful fighting man he is if he was one, but a certain amount of reading, particularly when one is young, is good for the mind. As David Harum might have said, "it prevents an officer

* No. 1, Oct. 1920. Clowes & Sons, 94, Jermyn St., W. 30/- per annum.

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brooding too much that when war comes along he gets most of the barrage and few of the Bradburys." Reading the right stuff to some extent takes the place of experience. When one gets out into the world there is less and less time to read. Lord Kitchener said in my presence in 1902, that since leaving Chatham he had had no time to read, and had only his own experience to go upon, and that he hoped to find time to read in India. I asked one of his staff subsequently if he did, and received the reply that he read no books except when he was in bed with a broken leg. I once complained to my Chief, Sir John Ardagh, that he had kept me so busy in the previous twelve months that I had only read a couple of books not directly bearing on my work. He looked up, sighed, and said " I haven't had time to read one." This is drifting into anecdotage and the Editor asked for a review, but it contains the moral that the busy man still wants to read but has no leisure, or at best has only time to swallow some of other people's experience and research in the tabloid form of magazine articles and reviews.

The first number of the *Army Quarterly* seems to provide both for the busy man and the more leisured student. The articles it contains will be enumerated and briefly commented on. Lieut.-General the Earl of Cavan gives a short sketch of the British operations in Italy from the commander's point of view, under the heading of " Some Tactical and Strategic Considerations of the Italian Campaign, 1917–18." It no doubt gives us much that passed through his own mind when faced with the realities of war. It is condensed experience. Lieut.-General Sir Noel Birch in a most interesting article, " Artillery Development in the Great War," tells us why Sir Douglas Haig in 1916 asked for more guns, and what he did with them; and describes the organization and staff that controlled the guns, and the innovations introduced and scientific progress made by the British artillery during the war. In " The Staff " an unsigned article, the British organization of G.S., A., and Q. as against the single staff of foreign armies is discussed. Lieut.-Colonel the Hon. Sidney Peel, a Territorial officer, writes on " The Territorial Force, its discipline, peace training, organization and expansion." He advocates that on mobilization all serving forces should come under the same administration and under one label, and points out the absurd anomalies that arose from regular captains of ten and twelve years' service being junior to recently appointed majors of the T.F. Lieut.-Colonel T. E. Lawrence's article " The Evolution of a Revolt," relates the story of the Arab revolt against the Turks in 1916, which he did so much to engineer. Those who bridged the Somme in 1917 and blew up or tried to blow their work up in 1918, and re-bridged the river a few months later, will hardly want to read Mr. Hilaire Belloc's " The Obstacle of the Somme Valley." He has overlooked in his historical retrospect that

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in the Agincourt campaign the French "cratered" the causeway at Voyennes by digging holes in it and that it took Henry V's sappers ("varlets" I am afraid the monkish War Diarist calls them) three hours to repair the roadway for traffic in single file.

Colonel Fuller of "Tanks" has in "The Foundations of the Science of War," as in every thing else he has written, provided a number of fresh and stimulating ideas. "The Flanders Battle-Ground" by Messrs. Fletcher and Atkinson of Oxford is an historical survey. "India at the Cross Roads" another unsigned article, points out that India escaped all the physical dangers of the war and should bear a fair share of the military burden.

The titles of the other articles explain their nature: "Educationin the Army," "Aircraft Co-operation with Infantry," "British Regimental Records," "Bernhardi on Reforms in Organization," "Notes on Foreign War Books."

At the end there are a number of pregnant short extracts from books on the war; busy people might read these, and these only, and learn a great deal. The *Journal* concludes with an official Appendix giving the Staff of the Army and Commands, Distribution of the Army, recent Army Orders, etc.

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PROFESSIONAL NOTES.

BRIDGING.

Mention was made in last month's notes that experiments were being carried out with a modified pontoon equipment for carrying medium and heavy loads in a somewhat similar manner to the Bridges B. and C. in S.M.E. Circular No. 25A. These experiments have now been made and may be briefly described as follows.

The ordinary standard pontoon was taken and strengthened or altered in certain ways. First of all two extra thwarts were fixed across the pontoon between existing thwarts and the pontoon decked in with $\frac{3}{8}$ inch planking running longways. This decking was then waterproofed in the usual manner with canvas, marine glue, etc., and a second layer of $\frac{3}{8}$ inch planking laid crossways. The pontoon was fitted with rowlocks which had special long shanks, and the usual anchor cleats were fixed to the decking. Small brass screw plugs were let into the decking for the purpose of pumping out the pontoons and cleats were provided to hold the saddle in position.

The next step was to strengthen the couplings. This was effected in the case of the lower couplings by using 3 inch by $\frac{1}{2}$ inch mild steel bar which ran the whole length of the pontoon along the lower edge. The ends of these steel bars are turned outwards and the sections of the pontoons are joined together by cover plates which fit over these projecting lugs and are pinned in position. The top couplings took the form of a double eye and pin joint, the straps being fastened to the deck of the pontoon. With these couplings it was found that four half sections of pontoon could be joined together and the whole pontoon immersed by pressing down in the centre without any ill effects.

With pontoons altered in this way the equipment was capable of being made up in three different forms. For light bridge the usual bridging baulks and saddle were used, but as the pontoons are completely decked-in there should be no fear of their being swamped by water splashing over the bows—a difficulty which appears to have been very marked on the Italian front during the war. With the special rowlocks it was found that rowing presented no difficulty. A raft was made up and was rowed up and down stream quite easily.

For medium bridge a pier is made of six half sections (*Fig.* 1). Ordinary saddles are placed on the pontoons and these are connected by eight short baulks which are very similar to the old half baulks

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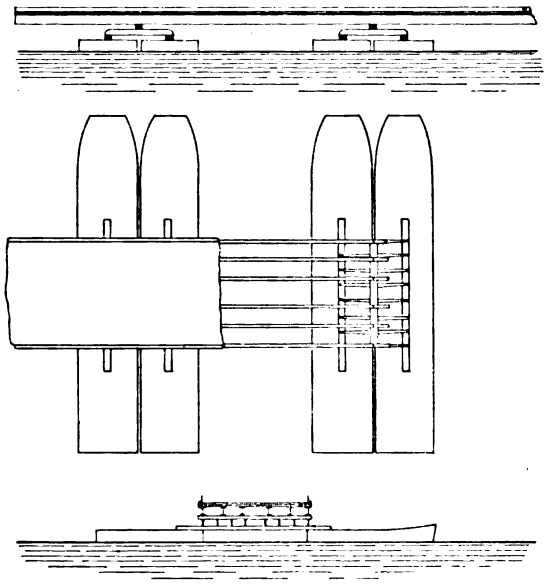

FIG. 1.—*Elevation, Plan and Section of Medium Bridge.*

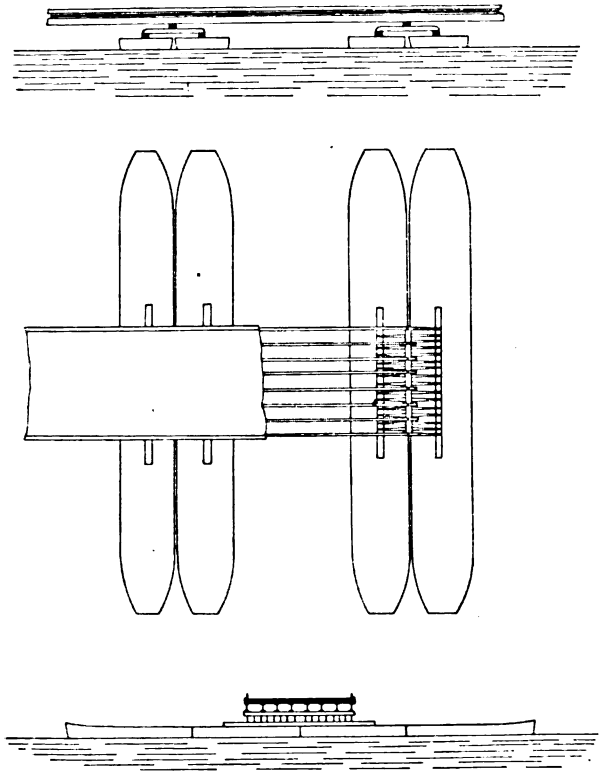

FIG. 2.—*Elevation, Plan and Section of Heavy Bridge.*

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which were used in the pre-war "heavy pontoon bridge." A special saddle is now placed across these eight short baulks; this saddle has cleats which are strengthened with steel plates. The span from one pier to the next pier is bridged with six 9in. by 4in. by 21ft. steel joists which fit on this special saddle and double chessing is used and held down with 6in. by 4in. steel angles.

For heavy bridge eight half sections are used; these are connected by sixteen short baulks. The same special saddle is placed on these short baulks and in this case eight 9in. by 4in. joists are used. Treble chessings is used in this case. (*Fig.* 2)

A trial with this equipment was carried out recently. The medium bridge was tested with a fully loaded lorry and the heavy bridge was tested with a 14-ton tractor. The equipment appeared to be quite satisfactory. More pontoons are now to be converted into this form so that further trials can be carried out.

The main object of decking-in the pontoon is to obtain extra buoyancy. With the usual allowance of 12 inches freeboard the buoyancy of a pontoon is 3·2 tons; with a decked-in pontoon 3 inches is a safe allowance for freeboard and the buoyancy then becomes 5·2 tons. This allows for the extra weight of the decking and strengthened couplings which amount to 300lbs. per half section.

The total dead weight due to the roadway of the bridge is 2·5 tons on each pier for medium bridge and 3·4 tons on each pier for heavy bridge. The medium bridge has six half sections and the heavy bridge eight per pier, so that the safe load which can be carried is 13·1 tons and 17·4 tons per pier for medium and heavy bridge respectively. Four half sections are sufficient to carry the ordinary 3-ton lorry, but have not quite the necessary buoyancy for medium loads which include heavy commercial lorries.

With reference to last month's notes there was a mis-print in the load table; the equivalent distributed load for medium loads should read :—

·6 tons, and not 6 tons per ft. run.

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THE "NISSEN" STANDARD BUILDING.

THE following notes on a visit to the large wool depot under construction at Hull by Nissens, Ltd., may be of value to R.E. officers. The name of the designer will probably be a "household word" in the army for generations, and this development of the idea which created shelter for countless British soldiers in France and other war theatres and is still sheltering thousands of civilians, is particularly interesting.

The depot at Hull covers an area of over nine acres under one roof. It consists entirely of the Nissen standard building, eighteen 40ft. spans, each 552 feet long, erected alongside each other and intercommunicating.

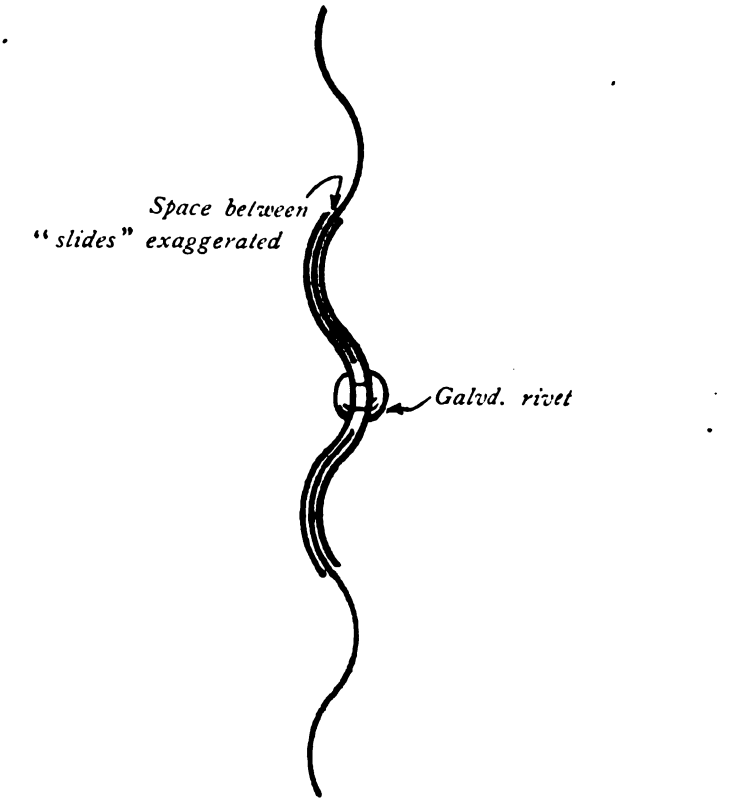

FIG. 1.—*Patent Joint between Sheets of Inner Lining.*

The standard building consists in essentials of a series of semi-circular arched ribs. These are at 5ft. centres, at Hull; this spacing could be increased with larger dimensions of the members, to 6ft. or 7ft.; the normal spans are 20 ft., 30 ft., and 40 ft., and a 50ft. span could be provided. At Hull the ribs are 3½in. by 3½in. Tees, in five

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equal lengths, fished together with the webs outside. At the base they are, at Hull, bolted to angle cleats which are bolted into longitudinal timber sleepers, the sleepers in their turn bolted into 2ft. deep concrete. In future patterns the sleepers will be omitted.

The sides and roof are a double skin of galvanized corrugated steel—outer covering 24 gauge, inner lining 26 gauge. In the inner skin the corrugations run horizontally; the sheets are not holed in any way, but are fixed in riveted "slides," the joint, shown in *Fig.* 1, being a "Nissen" patent. The sheets lie in the re-entrant of the tees, and are kept down by wires strained along the circumference of the roof. This inner skin can be replaced by reinforced plaster slabbing, which gives a finish of excellent appearance without increased cost.

In the outer skin the corrugations are, of course, circumferential; the sheets are lapped and bolted and fixed to timber purlins, 4in. by 3in., at about 4ft. spacing. The fixing of the purlins is very simple, as in *Figs.* 2 and 3. The air space between the skins is about 8 in.

Glazing in Haywood's patent lead-bar system is introduced between the purlins where required—in most buildings over the adjacent purlin spaces on the north side. The lighting is excellent. At Hull, the arch-ribs have a flat tie and round sagbar at a height of

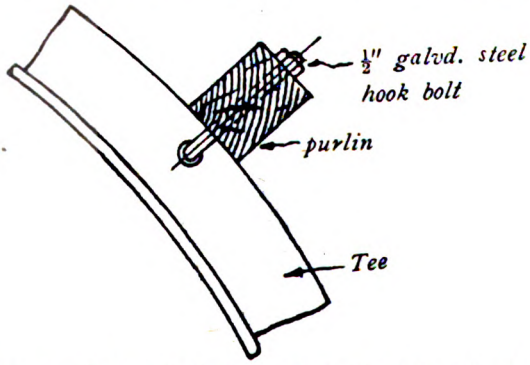

FIG. 2.—*Fixing of Purlins. End View (No C.I. shown).*

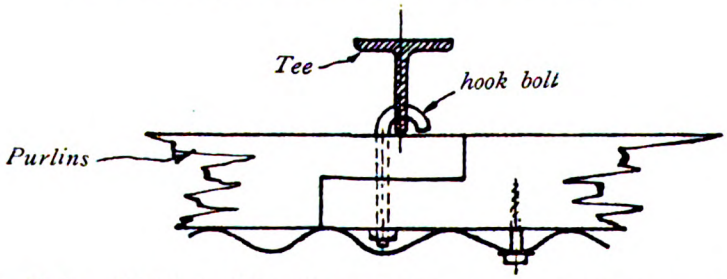

FIG. 3.—*Fixing of Purlins. Circumferential view, showing Scarf Joint in Purlin. (Inner Skin of C.I. not shown).*

NOT TO SCALE.

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about 16 ft. These are unnecessary and will be omitted in future designs. Ridge ventilation is not provided at Hull, but it would not be a very difficult matter to arrange.

Between adjacent spans, the sheeting stops at a height of 8 ft., and a galvanized steel gutter about 3 ft. wide is provided, with two down-pipes in the length of the building. The semi-circular gable ends are filled in with timber studding and a double skin of match-boarding, with a double door 11 ft. high and 10 ft. wide, two windows and a louvred ventilator, the whole painted. The ends could be of concrete blocks or corrugated sheets on framing.

The floor (tarmac or concrete) is not part of Nissen's contract. It is to be at the level of the bottom of the timber sleepers, the omission of which will, therefore, permit of a level floor without interruptions in future buildings.

It is claimed that :—

1.—The building being standardized, an order for so many feet run of any standard space can be executed very quickly.

2.—The building is permanent ; proof against high winds and earthquakes ; of even temperature, obviating condensation ; light and economical in maintenance.

3.—The material packs well for shipment, the curved members all " nesting," and erection demands a comparatively low grade of skill.

4.—Speed of erection is extremely high, and cost is low.

All the above points can be conceded.

A comparison of cost between the Nissen building and an ordinary steel building is difficult to make at the present time, when prices of steel work of all kinds are unstable. A comparison of the weight of the building with that of one of ordinary construction, however, is interesting. The Nissen building for a 40ft. span weighs under 9 lbs. per foot super of floor, everything *above* the floor level being taken into account. A modern steel building with pitched roof, 40ft. span on stanchions 8 ft. high, with roof and sides covered with a single skin of 22 gauge corrugated sheets, with no ridge ventilation, will work out at about 12 lbs. per foot super, and it will have the disadvantages of the " single skin " and of headroom nowhere over about 9 ft.

In speed of erection, judging by the Hull contract, the Nissen building is astonishingly successful. The depot will have been completed, as far as Nissen's contract is concerned, in about four summer months, by 40 men on piece-work ; the only additional labour having been 30 unskilled men unloading materials at the start. Railway sidings were laid to the site before work began, and the site was levelled. The effect of piece-work in the output has, of course, been very marked ; the men have been able to earn as much as £20 or even over per week, and this when compared with the amount,

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£5 or so, which they could have earned in ordinary day rates has kept them perfectly satisfied with the piece-work arrangements.

It cannot, of course, be claimed that a building with curved sides possesses every advantage of a high building on stanchions, and there are certain limitations to the utility of the construction. For storage of material in bulk, or for high vehicles, probably only about 90 per cent. of the width of any building could be considered available, though the extra height in the middle could be made use of. Intercommunication between existing spans is not so easy as with stanchions at the normal spacing of 10 ft.–12 ft., though extra wide openings could be made by special arrangements. The same remark applies to doors on the long sides of a building. The carrying of heavy shafting would not be a perfectly simple matter. The arch ribs could, of course, be erected on vertical stanchions, and a two-storey building erected; whether the same advantages in cost and rapidity would still be gained is, perhaps, not yet proved.

In spite of the limitations suggested above, the construction has very obvious interest from the War Department point of view, its range of usefulness extending from store buildings, light workshops, etc., to gymnasia and drill sheds, while its simplicity and speed of erection are undeniable.

The photographs show the buildings under construction, and give an idea of the appearance when completed.

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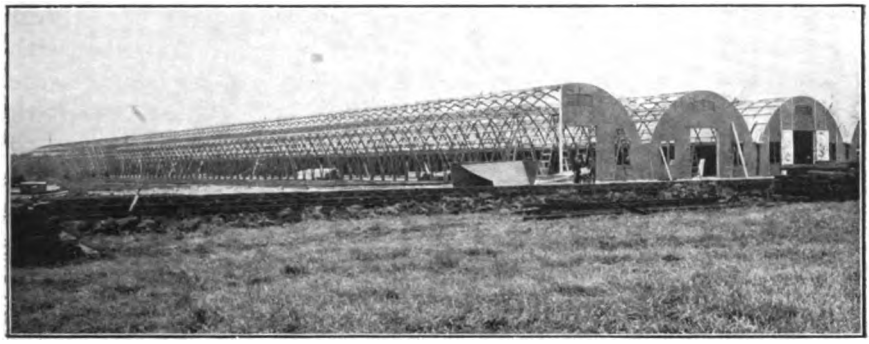
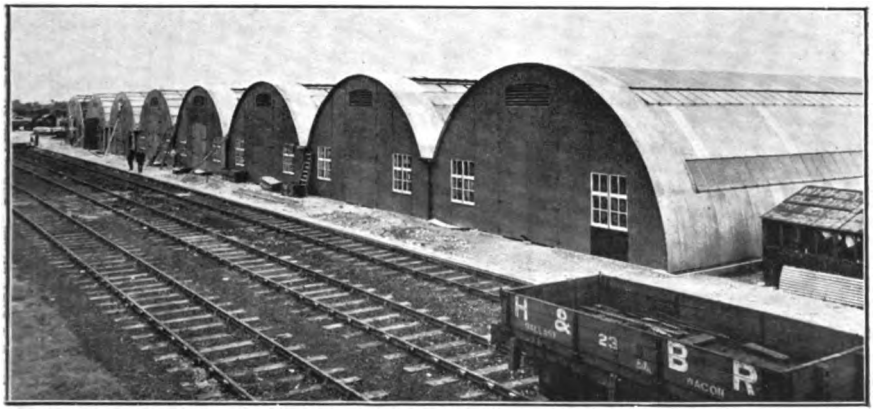
PROFESSIONAL NOTES.

The "Nissen" Standard Building.





The Buildings at Hull.

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REVIEW.

NOTES ON THE "TABLES DE PROJECTION (SYSTÈME LAMBERT)" AND ON THE KILOMETRIC GRID (CARROYAGE) FOR MAPS OF THE WESTERN FRONT.

Mr. A. R. Hinks, C.B.E., F.R.S., Secretary of the Royal Geographical Society, and the author of the above pamphlet, has been good enough to send a copy to the R.E. Library.

Maps of the Western Front for the British Expeditionary Force were prepared upon the Bonne Projection in use in Belgium; and our British-made sheets were an extension of the Belgian series, in order that we should have no break or change in the continuity of our maps. Wise as this decision was, it introduced, unavoidably, a change of sheet lines between ourselves and the French troops, and, further, the development of scientific methods of gunnery and of artillery intelligence showed up the weak points of the Bonne projection. Comparatively early in the war the French substituted for their own Bonne projection an orthomorphic, Lambert's second (conical orthomorphic with two standard parallels), and in 1918 an international allied commission met in Paris and agreed to the use (by all the allies on the Western Front) of this projection. In order to ensure full uniformity not only were our maps to be gradually re-drawn on this projection but the Kilometre grid and the French system of reference in defining points with relation to that grid were to be brought into almost immediate use. This decision was, as a matter of fact, never carried into execution, for the course of operations, and the comparatively large movements of 1918, made it impossible; but all preliminary measures and computations were completed. The calculations for the adoption of this new projection were facilitated by the existence of certain geodetic tables defining lengths on the meridian and parallel on the figure of the earth used by the "Service Géographique de l'Armèe." These tables were not, however, absolutely rigorous. Indeed they depend upon certain approximations or expedients which Mr. Hinks rightly describes as both "curious and doubtful." Projection tables for Lambert's conical orthomorphic derived from those geodetic tables were also prepared by the French and again certain approximations appear. The net result of this complexity of data was that plottable errors might well have been introduced by adhering rigidly to theory and that it became necessary to investigate, not only the details of the French solution, but how best to treat our own existing triangulation and maps.

Mr. Hinks' pamphlet tackles these questions with lucidity, and his paper was a most valuable contribution to the subject at a critical time. He refers in his concluding paragraph to the haste with which he had completed his work, but we must disagree with him when he says that many signs of this haste are apparent.

H. ST. J. L. WINTERBOTHAM, *Lieut.-Colonel.*

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NOTICES OF MAGAZINES.

MILITÄR-WOCHENBLATT.

No. 120.—A long list is published of those Prussian General Officers who complete in 1920 at least 50 years since their first commission. The *M.W.B.* thinks that their names are only too likely to be forgotten in these days of national humiliation.

The Superiority of the French Field Artillery in the War.—An article published in No. 114 asserted that this was nothing but a legend ; the subject has evidently given rise to a good deal of discussion and in this number Lieut.-Gen. von Rohne supports a contention of his in the *Artillery Monthly Review*, that the French artillery was superior not only in its material, but also in its employment. As regards material, he instances the greater range of the French gun, its flatter trajectory, and the greater effect of its shrapnel. The reliance placed by the Germans on their 4·2 howitzer is declared to spring from the defects of the field gun, and the fact that the French developed the field howitzer but little, is held to prove that their gun fulfilled most of their requirements. As regards employment, General von Rohne says the real judges of this are the infantry, not the artillery. He is in favour of open positions only when the task to be fulfilled cannot be carried out from covered ones, but is no believer in those who say that " open position " is synonymous with " death " ; still less in those who, at times during the war, thought that as the infantry had to suffer losses, the artillery should not be allowed to escape and consequently placed the guns right out in the open. General von Rohne says he has been strongly criticized for his writings. This example of them does not lead one to doubt it.

Representative Assemblies of the Army and Navy.—Following the general trend of the times, whereby every profession requires special representation, special " Chambers " have, by an order of the 3rd June, been constituted for the Army and the Navy. Now it is a question of taking the preliminary steps along a hitherto untrodden path, of collecting experience and leaving the door open for alterations. In the Ministry of Defence opinion is clear, that while in the days of a Supreme War Lord such an institution could be dispensed with, yet, under present conditions, it is desirable to establish means whereby the centre of the organization can be kept in touch with the circumference. These Chambers are consequently to be elected for this purpose, by secret ballot ; they will also be expected to voice the wishes of the troops and to support the execution of such orders as the Ministry of Defence may issue, even when these do not appear to take all views into consideration. The Chambers are therefore advisory bodies for the Chiefs of Army and Navy. That for the Army is to consist of 2 officers from Army H.Q., 1 General, 1 Regimental Commander, 1 Staff Officer, 2 Medical Officers

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from each of the 7 Defence districts, 1 Captain or Subaltern from each sub-district, and 13 N.C.O.'s and 29 men from various arms of all districts together. Certain other medical and departmental representatives are also provided for. The Chamber is organized into one main committee and six sub-committees. The main committee consists of 17 officers and 17 other ranks; the sub-committes deal with officers, doctors, vets., ordnance, N.C.O.'s and men. Methods of election are carefully laid down, and voting is to take place between 1st and 10th July. The whole project, which will to a great extent replace the German Officers' Union (D. O. B.) and the Federation of German Professional Soldiers, has been specially devised to avoid the danger of the Chambers turning into Parliaments, which could only work for their destruction, and with this in view, the size of the Chambers has been kept down and the time for which travelling, etc., allowances will be granted limited to three days at a time. The project is of an experimental nature only, but it is hoped that it will lead to the side-tracking of the many Army unions and federations which at present are often against good discipline and only foster unattainable and extravagant objectives. This apparently most important institution passes, curiously enough, entirely without comment from the *M.W.B.*

Germany and the League of Nations.—A writer in *Wissen und Wehr* advocates the earliest possible entry of Germany into the League of Nations, so that she may have a voice in the matter of her own armed forces. This, seeing that the League favours "Armament according to the requirements of national security and international obligations," could not be denied to her. The *M.W.B.* declares that the fears expressed outside Germany and particularly in French papers, that the destruction of armaments is not being carried out, are entirely groundless. Soon after the Armistice and before the Treaty was concluded immense quantitites of arms were destroyed of which no record was kept and a vast amount of war material was dispersed, lost and wasted by the disintegration of the Army. In addition to this, between July, 1919, and March, 1920, the following have been destroyed, viz.: 5,000 guns, 14,000 gun barrels, 8,500 gun carriages, 3½ million loaded shell, 31 million fuzes, 5,000 tons powder, and 32,000 tons of other explosives, 1,300,000 rifles, 24,500 machine guns, 94 million rounds of S.A.A., 4,000,000 hand grenades. On the 5th May, 1920, a further immense quantity of material had been set aside for destruction, including among other items 20,000 M.G.'s and 15 million shell. The whole of the aeroplanes, except 60 reserved for special purposes such as searching for mines, has been placed at the disposal of the Allies. The prescribed destruction of fortifications is said to have been carried out up to time, except when additional demands have rendered this impossible.

Roll of Honour.—Signal Corps: 112 officers and 3,325 other ranks killed or died of wounds or disease. It is remarkable that 67 of the officers died in the year 1918.

No. 1.—The *M.W.B.* now appears only once a week instead of twice, as hitherto. The price remains unchanged at 32 marks per annum, but each issue is slightly larger than hitherto.

The Further Disarming of Germany.—The writer protests against the

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allegations made by the Entente, that disarming is not going fast enough, and declares that it is the one business in which the German Government is showing any energy. Speeches by Lloyd George and Churchill are quoted in support of his contention.

The Regimental Officer in the World War.—Lieut.-Col. von Weitershausen contributes an article in his praise. From the glorious days of 1914 to the terrible ones of 1918 it was the regimental officer who bore the brunt of everything. The many virtues, of which he gave proof, were the fruit of long, exact and detailed training and regimental duty. Nowadays things are different; games and education find a place in regimental routine and there is little room for the detail of pre-war days, but the young officers of to-day cannot do better than hold the examples of work and self-sacrifice, exhibited by their predecessors, ever before their eyes.

No. 2.—The usual appeal against any reduction of the 200,000 strong army appears and all the old arguments for it are repeated.

German Naval Chronicles.—The official German account of events by sea is now beginning to appear. It is edited by Admiral von Mantey, Director of Naval Archives, and is entitled "The War at Sea; 1914–1918." The first volume takes us up to the beginning of September, 1914. It states that the cruise to the Norwegian fiords was undertaken in order to avoid any alteration of programme which might increase the political tension. The Admiral, on arrival in the Sogne fiord, heard of the ultimatum to Serbia and on his own initiative got the Kaiser to order the fleet to return home. This, in spite of the efforts of the Chancellor to get the order cancelled, it succeeded in doing. The purposeful procedure of the British Admiralty is compared with the half-hearted action of the Germans. The plan of operations, together with the appreciation of the situation on which it was based, is given in full. It in no way corresponds to the idea, held by a leading German statesman, that the fleet should be preserved in order to constitute a powerful political make-weight on conclusion of the war, but the reviewer does not think the Commander-in-Chief sufficiently emphasized the necessity for a vigorously offensive policy, to include even the capital ships, with the object of wearing away the British superiority until a decisive action could be accepted with good prospects of success. The influence of neutrals on the British blockade policy was much over-estimated.

German Military Sports.—Great efforts are evidently being made to get German military sports into going order. To judge from an article by a Reichswehr battalion commander, the higher authorities are going rather too quickly, and regimental officers, handicapped as they are by constant changes in *personnel*, find it difficult to make their performances keep pace with the new-born zeal for sport and games that their superiors evince.

The Situation in Austria.—France is said to be so opposed to any combination between Germany and Austria as to be willing to give to England a free hand in Asia Minor, if, in return, she obtains the right to regulate Austro-German relations. In accordance with her plans to weaken and isolate Germany, she is said to favour a consolidation of the Danube States, including Bavaria. Austrian relations with Tchecko-Slovakia

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are described as good, with Jugo-Slavia as fair and with Hungary as distinctly strained. Austria thinks Hungary is trying to bring about the downfall of her Government, and Hungary is angry with Austria for not surrendering Bela Kun and his associates.

Hungary after the Peace Treaty of 4th June, 1920.—Hungary loses 230,000 square kilometres of territory and 18 million inhabitants, besides the greater part of her economic resources. Her army, at present nearly 100,000 strong, has to come down to 35,000. The Government is making great efforts to improve its relations with its neighbours and succeeding in the case of all except Austria. A military convention with Roumania, and possibly with Poland, directed against Soviet Russia, is discussed in the press. The firm stand Hungary is taking against Bolshevism has led the ill-informed Labour organizations of Western Europe to agitate against her, as having instituted a " White terror."

Alleged Murder of German Prisoners.—" The wholesale murder in the Roumanian prison camp of Sipote," written by a German chaplain, alleges that out of 4,000 German and 13,000 Austro-Hungarian prisoners, there were after 6 months only 187 survivors. Exposure, starvation, and disease unchecked by any medical aid are said to have accounted for the rest. It is stated that 39 witnesses have testified on oath to the truth of these allegations.

Nos. 3 and 4 of the *M.W.B.* have not been received.

No. 5.—*The Projected Defence Law.*—Lieut.-Gen. Schwarte says that owing to limitations imposed by the Peace Treaty the scope of the new defence law can only be very restricted. It will, however, concern itself with the quality of the *personnel* forming the Reichswehr and in this connection he discusses the problems, so familiar to the British Army, but so strange to the German, involved in competing in the open labour market for recruits. He does not think that the requisite 96,000 men (the 100,000 includes 4,000 officers) will be forthcoming unless the unemployment increases or the standards demanded are lowered. Yet the small size of the army makes it essential that its quality be high and unemployment can only be harmful to the country as a whole. Further difficulties arise in connection with the liability for service of the contingents of particular states, outside the boundaries of their own territories. The proposal is to place responsibility for decisions in this matter on the military authorities, but considerable opposition is anticipated before this can be carried. It will call for the most careful thought to reconcile the requirements of the Peace Treaty, particularly that part of it which limits the number of premature discharges, with the consitutional rights of the citizen and the necessities of the Army. Undoubtedly these latter must have precedence over the rights of the citizen, says Gen. Schwarte ; they include loss of voting power and prohibition of political activities. This proposal is certain to be opposed, but yet it is essential if the Reichswehr is to form a trustworthy instrument in the service of the State. By judicious use of permission to take up part-time occupations and to marry, it is hoped to maintain high standards of personal efficiency. It is hoped that the Defence Law will not be made an occasion for party strife, but that all will combine to do the best that the circumstances of the case allow.

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The Military-political Situation of the World.—France is declared, in spite of all her troubles, to be the country least likely to suffer from Bolshevism. The vigour, which her Government always shows, towards any factions which tend to upset the State, form an example which Germany would do well to imitate. Belgium, by instituting 10 years' active and 5 years' reserve service, contemplates possessing a mobile army of a half a million by 1923. The Flemish movement is active, but not expected to come to anything, although the prosecutions of the Activists who showed themselves friendly to the Germans during their occupation, is causing much ill-feeling. Relations with Holland are very strained.

No. 6.—*National Defence Law.*—There has been no time in the present sitting of the Reichsrat to pass the projected National Defence Law, so, in order to comply with agreements reached at Spa, a provisional law has been passed, abolishing universal service, limiting the numbers to be allowed on establishment and laying down the period of 12 years as the minimum continuous service for all "other ranks"; that for officers will normally be 25 years. The competition among officers still serving, for posting to the 100,000 men army appears likely to be considerable and the lines on which selections will be made are laid down.

No. 7.—1914: *The Errors of the High Command.*—A long *critique* of General Percin's book is given. In it the question as to whether the introduction of 3 years' service by the French followed or preceded the increases voted for the German army, is discussed, and it is declared that there can be no doubt that it preceded the German increase. The writer indeed says that it was introduced at the urgent request of Russia. As to the employment of reserve divisions at the beginning of the war, it is stated that Germany used hers, from the very first, as front line troops, because she was confident of their fighting powers; France, on the other hand, nursed hers because she was not very sure of them and because, being largely composed of fathers of families, they were very expensive in pensions. The *M.W.B.* seeks to prove that the German reservist was the better man, not by reason of better equipment or larger number of active officers, or even longer training, none of which advantages he is declared to have had, but simply because he was the better man, being German. General Percin's statement that the French plans for the deployment of their armies became known to the Germans through the imprudence of a French Staff Officer is declared to be based on the fact that in the Spring of 1914 a brochure entitled "The German Concentration" was published in France. This was alleged by its anonymous author to have been based on a document found in a German railway carriage. It is now known that the then Lieut.-Col. B. wrote the book, and General Percin's dictum that, by showing what the French knew regarding the German plans, it was indirectly valuable to the Germans regarding the French plans, is upheld by the reviewer.

Reconciliation v. Revenge.—On the 4th August the *Vorwärts* published an appeal by a "Republican Officer" to all who have learnt in the war to hate war, to persuade their unregenerate comrades to put aside all thoughts of revenge and to devote themselves to reconciliation with their former enemies, with, of course, revision of the treaty. The

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request is also made that this appeal may be brought to the notice of all ex-enemy officers in the hope that it may lead to better feelings. The *M.W.B.* is very angry with this idea, which it calls perfect lunacy, and says that all who value their honour higher than their life will have nothing to do with such grovelling and whining.

L. CHÈNEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.
March, 1920.

THE PROBLEM OF PIERCING THE FRONT.

This article is by Capt. Raoul Hoff. After the offensive which saved France and has been called the Battle of the Marne, the Germans entrenched themselves, and were strong enough to impose the same defensive tactics on us. The possibility of such an eventuality had been more clearly apprehended by them than by us; they realized the terrible loss involved in attacking a prepared position, and all the possibilities of machine-gun fire, also the necessity for heavy artillery to destroy the enemy's defences, while we rashly relied on the value of forward movement.

In September, 1914, we were in no position to capture German trenches owing to our lack of heavy artillery, and to the exhaustion of our field gun ammunition. From the Oise to Switzerland no frontal attack was possible. An outflanking movement was only possible between the Oise and the sea, and this both sides attempted and failed to achieve. Both sides were now stabilized from the sea to Switzerland.

The offensive has always been conceived as combined with a judicious defensive, the object being to hold the enemy everywhere and prevent him from altering the distribution of his forces, while attacking him in force at some favourable point. A general defensive is the negation of warfare; a war of movement can alone produce a decision, but this must be subject to the destruction, at least partial, of the opposing fortified line, to admit of the offensive being resumed on open ground. Such a result the Germans attempted to achieve from 20th October to 13th November, 1914, at Ypres.

The problem of how to break through was presented for solution. Dimitrieff had been faced by the same proposition in 1912 when checked by the Chatalja lines. Having regard to the immense concentration of force involved, it appeared that the attempt could only be made on a narrow front. Land and air reconnaissance, and the necessary preliminary artillery bombardment, would preclude surprise.

The first French offensives took place in Champagne at the end of 1914 and early in 1915; they were mere trials and gave meagre results, but that of February, 1915, was not without use, in that it retained on the Western front a part of the German troops intended to take part in the offensive on the Mazurian Lakes. A gain of two or three kilo-

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metres is insufficient, it does not embrace the enemy artillery position, and therefore the consolidation of the conquered area is a costly process. The primary object of the offensive must be the enemy artillery.

The battle of Artois (9th May to end of June, 1915) which nearly succeeded, awoke the Germans to the necessity for organizing their positions in depth, so that the whole could not be simultaneously bombarded by the artillery. Thus the attacks in Champagne in September, 1915, only brought about the capture of the first position, and our infantry then found themselves opposed by a second line of defence.

Recognizing the difficulty of destroying the defences the Germans on 22nd April, 1915, between Steenstraete and Het Sas, introduced the use of clouds of poisonous gas to destroy the defenders. By this means our lines were penetrated for several kilometres, but our adversaries were so surprised by their success that they were not in a position to reap full advantage of it. The same phenomenon occurred later at the first appearance of the British tank, but the tanks, as the gas, were used in insufficient quantity, and only led to local successes.

The Germans made their first attack aiming at a definite decision at Verdun in February, 1916, but they made a great mistake in prolonging the battle after equilibrium had been established. Later on we repeated this mistake at the battle of the Somme. These two ineffectual attempts demonstrate that a battle of attrition on a narrow front should always be avoided in view of the heavy losses it entails.

At the beginning of 1917 the Germans, foreseeing the imminence of our attack prepared on the Somme, retired on the Hindenburg line, obliging us to follow, and halt, in country deliberately devastated, but though our plans were upset our offensive on the Aisne was not prevented. Here the Germans had collected large reserves, and their counter-attacks were effectual, but we did wrong in abandoning the engagement, for the German reserves had all been absorbed while ours had hardly been called upon. Possibly political considerations intervened and prevented the termination of the war at this date.

A new element, the tank, made its appearance in the British attack towards Cambrai at the end of 1917, and proved that a surprise attack might still be possible. The British succeeded, after a formidable but short artillery preparation, in crossing the enemy's lines, the tanks opening gaps for the infantry. Unfortunately the initial considerable success could not be developed, but the tank gave grounds for great hopes of its value.

If the battles of 1917 showed that the break-through was difficult, the events of 1918 proved that it was not impossible, for twice, at the Somme, and on the Chemin des Dames, the Germans captured the whole of our defensive system on narrow fronts. Still, from the middle of 1917 the French Great General Staff was convinced that a break-through would not ensure victory. It is a matter of regret that from September, 1915, the fact had not been grasped that the problem could be solved in a more rational way. We reached the truth before the Germans. The latter pinned their faith on breaking through subject to this being preceded by a surprise, but the apertures they forced were narrow, and could ultimately be closed again. In October, 1917, the instructions

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of the French General Staff were that successive attacks must be made on the same front to annihilate the capacity for offence, and weaken the defensive power, which could only be effected by a battle of attrition on a considerable front, executed as rapidly as possible so as to produce a general laceration of the whole body. Such a conception could only be brought to fruition by absolute superiority in men and material. Marshal Foch, the true genius of the war, knew how to embrace the doctrine proceeding from these fundamental truths, and thanks to the science of our leaders and the heroism of our soldiers, was able to turn it to practical effect.

A. R. REYNOLDS.

REVUE MILITAIRE SUISSE.

No. 6. *June*, 1920.

REORGANIZATION OF THE INFANTRY ARM.

The article on the above subject by Major Schmidt begun in the number of the *Revue* for May, 1920, is continued in the number under notice. Attack formations of the infantry are dealt with in this part of the original article. The problem of breaking an enemy's front is, it is suggested, analogous to that presented to a woodman who is called upon to split a log of wood with a wedge and hammer. Consequently, the formations employed in the infantry attack should be such that the arms first brought into use should produce effects similar to that obtained by the wedge in the splitting of wood; then should follow the troops possessing the driving force analogous to that of the woodman's hammer. In the attack, machine-guns play the rôle of the wedge, whilst the infantry supporting lines behind these guns represent the hammer. The subject is developed from this point of view in the original article.

ARMY REORGANIZATION.

The original article is contributed by Major Secretan, who deals with the subject of non-commissioned officers, their training and status. He points out that the Great War has proved that an army must be provided with an ample supply of subaltern officers and non-commissioned officers, thoroughly trained and organized on sound lines. He discusses matters relating to the training provided in the Swiss Army for the non-commissioned ranks and makes certain suggestions, which have in view the amelioration of their status.

NOTES AND NEWS.

France.—A Special Correspondent deals with the Court of Inquiry which has recently exonerated General Fournier, and the officers who were under his command, from all blame for the surrender of Maubeuge in 1914. He points out how exceedingly difficult was the task that confronted many of the French officers placed in command of the frontier forts and fortresses in Northern France on the declaration of war in August, 1914. The troops that were detailed as garrisons for the forts

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and fortresses were brave enough, but they lacked military training, which proved a most serious handicap. Regret has been expressed, it is said, that the French Higher Command had, prior to the declaration of war by Germany, failed to appreciate the true importance of permanent fortifications. Had the military authorities kept up the defences of Lille, strengthened Maubeuge, and provided Laon and Rheims with defence works, the whole course of the war would, it is suggested, have been very different to what it was, and probably fair provinces of France would have been saved from devastation. But, it has to be recognized that in the same way that an artillery armament cannot be efficacious unless there are skilled gun-layers in the teams that work the pieces, so in the case of fortifications the defence works are of little value unless troops of the proper quality are available to make *suitable* use of such defences. The following works dealing with the Great War have been recently published in France: *La Bataille de Foch* by Raymond Recouly and *Quatre années de commandement* (1914–1918) by General Dubail.

United States of America.—A Special Correspondent points out that one of the results of the introduction of conscription in the United States of America has been to provide the military authorities with documents of unique value, documents which provide valuable information relating to the physical, economic, industrial and ethnographic conditions affecting a large proportion of the American people. America had four million men under arms, excluding those serving in the Navy, during the Great War; of these 2,086,000 men served overseas. The total number of men killed in action, died of wounds, etc., amounted to 77,118; a table is given in the original article classifying these casualties. The *American Legion*, an Association of the Veterans of the Great War, has pronounced in favour of compulsory military service; its propaganda is, however, meeting with much opposition among congressmen, both on sentimental and also on financial grounds.

BIBLIOGRAPHY.

Notices are published relating to two works, *Reims devastée* by Paul Adam (published by the Librairie Felix Alcan, Paris, at 2fr. 75c.); and *Die Schlachten und Gefechte des grossen Krieges* 1914–1918 by Herman Sak (on sale at the Burgverlag, Nuremberg, at 23 marks.)

No. 7. *July*, 1920.

SEARCH-LIGHT PROJECTORS.

The original article is contributed by Lieutenant Sagne of the Swiss Army. He points out that, at the present day, with the setting of the sun there does not follow necessarily a cessation of active military operations as was the case in days of old; the military engineer can now at nightfall effect an illumination of the ground on which troops may be operating, or are about to operate, in every case as brilliant as that produced by the rays of the sun. Lieutenant Sagne briefly touches upon the crude expedients adopted in former times artificially to light up positions, in attack and defence, during hours of darkness. He refers to the employment, in modern times, of electric search-lights in warfare,

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and the uses to which this method of illumination can be put; and finally deals with the technical aspects of the problems involved in relation to the design of the plant required for the purpose.

The Army and Finance.

The original article is by Colonel de Diesbach, who states that the late War involved Switzerland in considerable discomfort and vast expense. The financial burden which Switzerland has had to bear in order to keep inviolate her territory has impoverished her, and the pressing problem which requires solution to-day is that connected with the maintenance of an adequate defence force on a military budget reduced to very small dimensions. Colonel de Diesbach puts forward proposals as to the manner in which the existing situation may be met in Switzerland.

From Charleroi to the Marne.

Colonel Poudret is the author of the original article; he calls attention to the works which have recently been published in Germany dealing with the opening phases of the Great War, and points out that, the great protagonists having recently favoured the world with accounts of the part they severally played in the critical operations during the advance to the Marne, it now becomes an easy matter to follow in detail the operations of the three Armies which formed the German right wing. Colonel Poudret makes a critical examination of the operations of the German right wing in the light of the literature that has recently been published with a view to ascertain upon whom rests the responsibility (on the German side) for battle having been given on the Marne under circumstances so unfavourable to the German Army. Von Kluck, it would appear, was in too great a hurry; he seems to have disregarded both the letter and the spirit of his instructions. (*To be continued*).

Notes and News.

France.—A Special Correspondent who contributes notes in relation to military matters severely criticises those responsible for the decision contained in the ministerial decree forbidding the discussion, in public, of military matters by army officers. It is suggested that in view of the numerous works that have been recently published by officers of high rank in relation to the Great War, works which contain numerous quotations from official documents, the apparent attempt made to prevent the truth in matters connected with the War from leaking out has alone the effect of bringing the authorities into ridicule.

Italy.—A Special Correspondent deals with the violent oscillations in the political situation in Italy at the present day and the effect of these oscillations on the Italian Army. There have been four changes in the political headship of the Italian Army within the space of a few months. Sr. Bonomi is again Minister of War, having succeeded Sr. Rodino. The reorganization of the Army is still in progress; in the new organization the General Staff has ceased to be a *Corps* apart, officers are in future to be appointed *for a term of duty* to the General Staff. It is stated that although in relation to technical matters the officers of

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the General Staff have rendered eminent services, yet as a Corps their influence on the Italian Army has been disastrous. Among the other reforms announced is the reduction in the number of regiments of Bersaglieri from 12 to 4. The disbandment of the regiments of this famous Corps is much resented in centres such as Milan and Ancona. The situation in Italy is still a troubled one.

W. A. J. O'MEARA.

CURIOSA MATHEMATICA No. 2.

SOLUTIONS to the above have been received from Major F. R. H. Eustace, D.S.O., and Major C. R. Satterthwaite, O.B.E.

The following note has been received from a correspondent :—

NOTE ON "CURIOSA MATHEMATICA" No. 2.

The numbers from 1 to 100 are for the most part quite easy to express by the use of "four fours," but when certain of the larger odd numbers are reached difficulties arise, and the question as to what mathematical symbols it is legitimate to use must be decided. The whole problem can be solved by the use of decimals, factorials, and the square root sign, but all solvers have employed some other symbols, the legitimacy of which is questionable. The integral sign must be rejected, as it surely involves x : once x creeps in $\frac{x}{x}$ can scarcely be rejected. Tan $\frac{\pi}{4}$ again is inadmissible, else cos π must be allowed. Colonel Cunningham's Γ symbol is not generally enough used to be really legitimate : "antilog $\sqrt{4}$" is cumbrous and of no definite meaning unless the base is stated, $\Sigma 4$, meaning $1+2+3+4$, may be admitted, but one prefers to do without it : the same remark applies to the use of the signs for Permutation or Combination.

The following are some of the most difficult of the numbers, constructed without any of the adventitious aids referred to above :—

71. $\dfrac{\lfloor\underline{4}+4+\cdot 4}{\cdot 4}$

73. $\dfrac{\sqrt{4}\cdot\lfloor\underline{4}+\sqrt{\cdot 4}}{\sqrt{\cdot 4}}$

77. $\left(\dfrac{4}{\cdot 4}\right)^{\sqrt{4}}-4$

83. $\dfrac{\lfloor\underline{4}-\cdot 4}{\cdot 4}+\lfloor\underline{4}$

87. $4\lfloor\underline{4}-\dfrac{4}{\cdot 4}$

These should be sufficient to indicate the methods by which all the other difficult numbers can be formed.

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PROBLEMS.

PROBLEM 13 (Solution by Major C. N. Satterthwaite, O.B.E.).

Is it possible to construct a triangle other than an isosceles triangle such as (i) all the sides are rational, and (ii) the perpendiculars from each vertex on the opposite sides are all rational?

Note.—The following construction does not guarantee the resulting triangle against being isosceles. There is no reason, however, why it should be so, and in practice it will not usually be so.

First, let us attempt to draw two unequal rational-sided right-angled triangles having a common side (not the hypotenuse).

x^2+y^2, x^2-y^2, $2xy$, are the sides of a rational-sided right-angled triangle, where x and y are rational and $x>y$.

For the common side, choose an integer which can be written $2mpq$, where m, p, q, are rational and —

$$\left.\begin{array}{llll} p & \text{is not equal to} & q \\ mp & ,, & ,, & q \\ mq & ,, & ,, & p \\ m & ,, & ,, & 1 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(i).}$$

This can be written $2.mp.q$

or $2.mq.p.$

These are the sides of rational right-angled triangles whose hypotenuses are

$$m^2p^2+q^2$$

$$m^2q^2+p^2$$

These hypotenuses cannot be equal under the conditions at (i); hence two unequal rational right-angled triangles can be so drawn, with proper selection of the common side.

Now let ODB, ODC be two such unequal rational-sided right-angled triangles.

Draw CE at right angles to BO, cutting BO, produced if necessary, at E. Let DO and CE, produced if necessary, meet at A. Join AB, cutting CO, either produced if necessary, at F.

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The resulting figure will be either such as *Fig.* 1 or *Fig.* 2; and ABC will be a triangle fulfilling the required conditions.

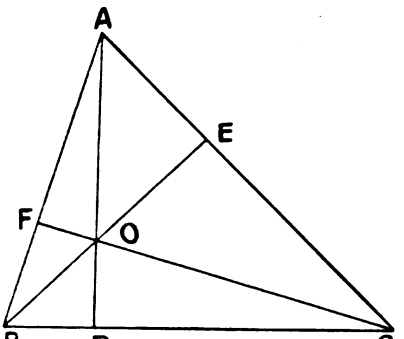


FIG. 1.

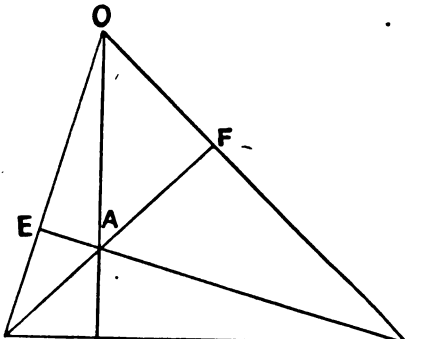


FIG. 2.

Taking *Fig.* 1; since BE and AD are perpendicular to AC and BC, CF must be perpendicular to AB.

Now ODB, OEA, CDA are similar triangles; all sides of ODB are rational and so is CD.

$\therefore$ DA, AC are rational, and so is AO (= AD − OD).

$\therefore$ OE, EA are rational, and so is EC (= AC − EA).

$\therefore$ BE (= OB + OE) is rational.

Again, OFB, OEC, AFC are similar triangles; all sides of OEC are rational and so are OB, AC.

$\therefore$ OF, FB, AF are rational.

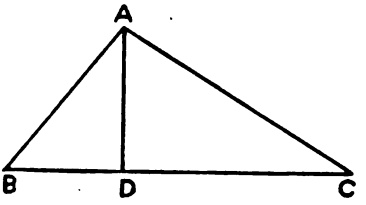
$\therefore$ CF (= OC + OF) and AB (= FB + AF) are rational.

Hence all sides and perpendiculars are rational.

Similar reasoning applies to *Fig.* 2.

The following solution is by Lt.-Col. Wade.

Is it possible to construct a triangle so that all the sides and altitudes are rational?



AD is an altitude.

Denote $\sqrt{s \cdot s-a \cdot s-b \cdot s-c}$ by N.

Then $AD = c \sin B = \frac{2}{a} N$.

Let $s-a=p^2$ $s-b=q^2$ $s-c=r^2$.

Then $3s-a-b-c=p^2+q^2+r^2=s$.

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Hence since $a \cdot b \cdot c$. are rational all the altitudes will be rational if $\sqrt{p^2+q^2+r^2}$ is rational.

Let $$p = m^2 - n^2,\ q^2 = 4m^2n^2,$$

then $$p^2 + q^2 = (m^2+n^2)^2.$$

Let $$r = (m^2+n^2)\frac{2gh}{g^2-h^2},$$

then $$p^2+q^2+r^2 = (m^2+n^2)^2\left(\frac{g^2+h^2}{g^2-h^2}\right)^2$$

The values of $a \cdot b \cdot c$ are as under :—

$$a = (m^2+n^2)^2\left(\frac{g^2+h^2}{g^2-h^2}\right)^2 - (m^2-n^2)^2$$

$$b = (m^2+n^2)^2\left(\frac{g^2+h^2}{g^2-h^2}\right)^2 - 4m^2n^2$$

$$c = (m^2+n^2)^2$$

$$N = \frac{4\,mngh\,(m^2\times n^2)^2\,(m^2-n^2)}{(g^2-h^2)^2}$$

It can be easily verified that with these values any two of $a \cdot b \cdot c$ are greater than the third. Hence by giving any values to $m \cdot n \cdot g \cdot h$. as many triangles can be found as are required.

If $$m = 2\ n = 1\ p = 2\ q = 1$$

we get the following values :—

$$a \cdot b \cdot c \text{ . are } \frac{544}{9} \cdot \frac{481}{9} \cdot \frac{225}{9}.$$

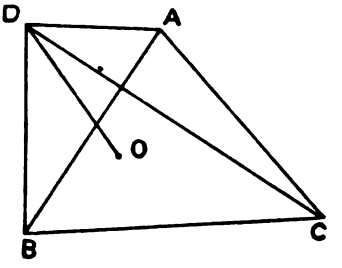
$$s-a \cdot s-b \cdot s-c \text{ are } 9 \cdot 16 \cdot \frac{400}{9}$$

$$s = \frac{a+b+c}{2} = \left(\frac{25}{3}\right)^2$$

Hence sin A, sin B, sin C are all rational and their values will be found to be < 1.

PROBLEM 15 (Solution).

Of all the pyramids standing on a given scalene $\triangle$ and having the same volume, which has the greatest inscribed sphere?



Consider the tetrahedron DABC, the fixed base being $\triangle$ ABC.

AB, BC, CA are c, a, b, as usual.

The areas of the faces opposite the solid angles A, B, etc., will be denoted by A, B, C, D.

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Then if R be the radius of the inscribed sphere

$$R\,(A+B+C+D) = \text{const.}$$

Then when R is greatest $A+B+C$ must be a minimum, and this is equivalent to the condition $pa+qb+rc$ must be a minimum where p, q, r are the lengths of $\perp^{rs}$ from D on BC, CA, AB.

O is foot of $\perp^{r}$ from D on ABC, and x, y, z are lengths of $\perp^{rs}$ from O on BC, CA, AB.

Then $ap+bq+cr = a\sqrt{h^2+x^2}+b\sqrt{h^2+y^2}+c\sqrt{h^2+z^2} = u$, say ...(1).

Where (h) is the length of DO (constant).

We have also $ax+by+cz = 2$ area of ABC $= \triangle$, say..... .....(2).

We have to find the minimum of (u) subject to condition (2).

Differentiating (1) partially with regard to x and y in succession and equating to zero gives

$$\frac{x}{\sqrt{h^2+x^2}} - \frac{z}{\sqrt{h^2+z^2}} = 0 \qquad \frac{y}{\sqrt{h^2+y^2}} - \frac{z}{\sqrt{h^2+z^2}} = 0,$$

whence $x = y = z.$

This condition must give a minimum, since as it is possible to increase the area of the faces A, B, C without limit, there is no maximum.

Hence the tetrahedron, with minimum superficies, is that in which O is at the incentre of triangle ABC, and the faces DBC, DCA, DAB consequently equally inclined to the plane of ABC.

Since writing this I have found this problem among the examples in Edward's *Differential Calculus*, p. 430, No. 19. My result is the same as that stated in the "Answers to the Problems."

PROBLEM 17.

Find the equation of the directrix of the parabola given by the parametric equations $x = at^2+2bt$, $y = At^2+2Bt$ where a, b, A, B are constants.

PROBLEM 18.

An elastic string of weight (W) per unit of length when unstretched and of modulus of elasticity $2a$W rests in contact at every point of a smooth vertical semicircle of radius (a) whose base AB is horizontal and whose arc is uppermost. The ends of the string reaching down to A and B. Find the unstretched length of the string.

J. M. WADE, *Lt.-Col.*

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THE SUPPLY OF ENGINEERING STORES TO THE ARMY IN THE GREAT WAR.

(*Lecture given to the Engineering Faculty, University of Liverpool, 5th March*, 1920, *by* MAJOR-GENERAL SIR GEORGE K. SCOTT-MONCRIEFF, K.C.B., K.C.M.G., C.I.E.)

IN modern times we have learned that a nation at war must avail itself to the fullest extent of all developments of engineering science, not only in the manufacture of weapons and ammunition, not only in the supply of accessory adjuncts of war such as railways and transport vehicles, but also in the actual operations of battle. Engineering must be closely and intimately allied with military operations.

The experience of the South African war, carried out against an enemy composed largely of mounted troops skilfully handled and possessing an initial advantage in their knowledge of their country, tended to obscure the fact that a campaign in a closely populated European country called for very different procedure; and consequently the vital connection between engineering and operations of war was not realized by the General Staff.

It is here proposed to consider a special phase of the engineering problem as it existed in 1914, to sketch the steps which were taken to grapple with that problem, and show how the work at home had to be in close touch with the operations in the field. This problem was how to meet in the most expeditious and thorough manner possible the supply of engineering stores and plant to the armies.

It is probably unnecessary to dwell upon the importance of this matter. Any one who has had to carry out engineering work at a distance from the centres of organized labour and the markets for materials, knows how vitally important is this question of supply, how it varies with the progress of the work, how necessary it is that supply and demand should synchronize, how it necessitates the closest co-operation between the engineers on the spot and the consulting engineers at home, and how any failure to maintain this co-operation leads to delay and expense. It is important that there should be a controlling head who understands at once the nature of the problem to be solved and the means, both locally and at the base, for enabling that problem to be successfully and economically handled.

At the outbreak of the war there were the following Departments of the War Office connected more or less with engineering science:—(1) The Directorate of Artillery, whose duty it was to provide weapons of war and ammunition. This duty was afterwards transferred

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bodily to the Ministry of Munitions, the Directorate, however, remaining in an advisory capacity. (2) The Directorate of Movements, which had as one of its branches the charge of railway operations. In peace time the engineering questions involved were obviously very limited, and the outbreak of war brought upon the branch concerned a great strain, and so great an expansion that ultimately the existing machinery broke down. So a large new Directorate of Transportation, including railways, roads, harbours and inland water transport was, after some two years of war, formed in the field with a corresponding Member of the Army Council at home. (3) The Directorate of Barrack Construction, an architectural branch which dealt in times of peace with the designs of large new permanent barracks and hospitals. This was abolished during the war as it was no longer required. (4) The Directorate of Supply and Transport, which dealt with mechanical transport, a most important and valuable, though obviously limited, branch of engineering. (5) The Directorate of Fortifications and Works, which dealt with buildings of all sorts, and all civil, mechanical, and electrical engineering as applied to military needs other than those already enumerated.

It is with reference to the work of this last Directorate that attention is now invited and to consider one special phase of that work.

From the skeleton nucleus of an organization which existed in 1914 the work of the Directorate expanded rapidly, shortly after the outbreak of war, into 12 branches or sub-divisions, designated in the War Office list as :—F.W. 1, F.W. 2, and so on. Of these 12 branches probably the most important were :—

F.W. 2, which dealt with the enormous programme of hut, barrack and hospital accommodation in the United Kingdom.

F.W. 3, which had to carry out all the coast defences, the largest programme of its kind for half a century.

F.W. 8, the Chief Mechanical Engineer's branch, about which I propose to speak presently.

F.W. 9, whose work as Chief Electrical Engineer was marvellously important and extraordinarily interesting. All the work of the signalling branch, of the wireless experimental work, both on the ground and in aircraft, all the searchlights, both fixed and mobile, all fixed electric lighting, and all inspection of authorized engineering *equipment of every description*, came under the duties carried out by this branch. The scope and value of its operation increased as the campaign went on, until at last electrical supplies in civil life became so inadequate that we had to take over and work five factories in and round London for the manufacture of field telephones, cables, and wireless sets both for ground work and aeroplanes. A large and important wireless experimental station formed part of the work, and it was largely due to the experiments carried out here that wireless telephony between aeroplanes in the air was successfully accomplished.

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To give an adequate account of all this work would far exceed the limits of an ordinary paper and therefore it is proposed to limit our attention to the other subject, namely, the supply of engineering stores for purposes other than electric signalling and searchlights.

It is perhaps unnecessary to say that a huge organization, comprising 12 important branches under one head, was only practically workable by having each branch under very capable management, a senior officer being in responsible charge of the operations in each. There were extraordinarily able men in charge of these, and their loyalty and energy were as conspicuous as their technical capacity. They kept the head of the department fully informed of all the important phases of their work, and took no vital step without his knowledge and sanction, consulting him freely in any difficulties; but beyond that they had freedom to act as they thought best. Some left for active service in the field, some died at their posts, but for the most part the same staff remained all through the war.

It is necessary at this stage to point out the difference between what are known as "Vocabulary" and "Non-vocabulary" stores. The former include ordinary tools of all sorts and all the equipment authorized for the use of technical units. The patterns of these have been authoritatively fixed and the Ordnance Corps is responsible for arranging for their supply, after technical inspection by F.W. 9.

But there must be in every work of engineering other stores, or special articles, or technical plant, which vary according to the particular needs of the case, and it is these that are called "Non-vocabulary" stores. In ordinary times of peace any such special plant or machinery either forms the subject of separate estimate and contract, or is included in a comprehensive scheme for some large work. In war, however, this procedure is impossible. The conditions of the problems are frequently so varied that it is impossible to forecast, except in very general terms, what materials, plant or machinery will be required, and it is equally impossible to maintain a reserve of such stores.

At the War Office, in August, 1914, there was the beginning of an extensive stores organization, in that there was an officer called the Inspector of Iron Structures, whose duties included the design and provision of fixed machinery for military purposes at home and abroad, and also the arrangements for shipment (in consultation with the Director of Contracts and the Admiralty) of engineering stores to Colonial military stations. The officer who held this appointment at the outbreak of war, Major (now Colonel) Oakes, was a mechanical engineer of large experience. He had been locomotive superintendent for six years on the South African railways, and had other varied experience which very thoroughly qualified him for the heavy task before him. He had, on the outbreak of war, not only to purchase stores for all branches of the Directorate

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of Works, but also plant and material for the Director of Railways. Later on he had to obtain for the Inland Waterways and Docks, barges, cranes, and other plant, and for the R.F.C. he had to obtain special waggons, machines and tools, as well as motor ambulances, aeroplane trailers, mobile and stationary workshops, etc. Each of the branches mentioned formed eventually a supply organization of its own, so that by the end of 1915 as regards railways, and 1916 as regards the R.F.C., each was able to stand on its own legs, but during the earlier stages F.W. 8 had supplied the Railway and Inland Water Transport branches with materials valuing £700,000, and the Royal Flying Corps with stores value £1,500,000. Further, when the German advance in 1914 placed the French Chemin de Fer de l'Est in a difficult position and they applied to England for assistance, F.W. 8 placed many orders for girders and permanent way for them, the value of such stores being over £92,000. These stores were ordered, inspected, shipped and delivered to the French engineers who thanked the War Office, not only for good quality and workmanship, but for punctual delivery and care taken to meet all their needs. Later in 1917–1918, when the American armies came into the campaign, they too had to come to us for their engineer stores. Urgent orders came rapidly pouring in for ordinary huts, hospital huts, water piping, pumping plant, steam navvies, and many other articles, the names in some cases being very unfamiliar. These orders came at a time when the steel and labour problems were very acute in this country, but long before the American Army had their own shipping organization in working order, we were sending over for them to France a steady stream of plant and materials, and with very harmonious relations between us. The value of the orders placed for the United States Army between August, 1917, and December, 1918, was £1,500,000.

It will be seen, therefore, that in addition to supplying the needs of the engineers of the British Army on all fronts, F.W. 8 was acting as a step-father to other departments of our own army, and to two, at least, of the Allies.

Before relating how the vicissitudes of war were reflected on the work at home, I should like to say a few words about the home organization.

The first step was to have absolute control over contracts. This was a notable departure from ordinary War Office procedure, but fortunately at the outbreak of war the Director of Army Contracts was a man with breadth of view, and he knew us sufficiently well to trust us. Ordinarily a contract of this description for machinery or other plant would take from a fortnight to three weeks to complete, but by having the power to settle contracts by telephone if necessary, or in any case directly, we were able, on a constantly rising market, to save not only huge sums of public money but precious time, and possibly precious lives.

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Several times attempts were made to take away this power of placing contracts but the attempts never succeeded. Often we were able to settle details by telephone and then to follow up immediately by written confirmation, and reports were made regularly to the Director of Contracts informing him of what we had done. The guiding principles in placing orders were :—

1. Rapidity of delivery.
2. Economy in price.
3. Efficiency of inspection.
4. Complete records of every order from manufacture to docks, thence by ship to overseas depôt.

The staff of the branch rapidly increased from a total of 25 all ranks in 1914 to 192 in 1918. The percentage of the cost of all administration during the war worked out to between 6s. and 7s. per £100 of expenditure. Considerable difficulty was experienced in obtaining War Office sanction for these increases of staff and for the necessary office accommodation ; the normal administration of the War Office secretariat not understanding the need for such continual growth. No doubt if F.W. 8 had been a new Department of State there would have been no difficulty ; some large hotel would have been commandeered for their accommodation and the staff would have been increased to any extent, but being only the branch of an old-fashioned, already-established organization, there was considerable reluctance to allow it to expand.

It will be explained later why the policy of not handing over the work to a new department was continually and successfully resisted. It may be of interest to record the fact that the officers who joined the branch after the first few months of the war were all civil engineers who had been serving in the field and who had been wounded or otherwise unfit for active duty.

At the outbreak of war it was clear that special arrangements must be made to watch the shipping of engineer stores complete in all parts, with due procedure of details and with promptitude. Experience in past wars had shown the need of this and of supervision over the work of loading ships. An officer was at first stationed for this purpose at Southampton, but it was very soon evident that however zealous he might be—and he was one of the best—he was heavily handicapped by his distance from headquarters. Accordingly, arrangements were made early in 1915 to utilize the South West-India Docks in London, whereby the shipping officer was in touch with contractors, railways, Port of London Authority, the naval transport officer, the consignees overseas, and F.W. 8 who could control the relative importance of consignments. By improving the railway facilities at the docks the deliveries of cargoes to ship or shed were speeded up and for a while ships were plentiful, but as

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demands from other departments for shipping increased, trouble began with the Ministry of Shipping and the Admiralty---a matter of grave anxiety, for demands from the fighting troops for engineering stores were becoming daily more and more urgent. In the summer of 1915 it was at last agreed by the Ministry of Shipping and Admiralty that a fleet of 10 vessels should be detailed for F.W. 8 stores to France. This was a considerable relief but the number of 10 was not always forthcoming and there was constant anxiety and uncertainty to make the best of the allotted vessels.

In addition to shipments from London a regular service of vessels left Liverpool with corrugated sheets, Rochester with cement, and the Channel Islands with road metal. The submarine menace in 1917 stopped the Liverpool services, and shortage of shipping by that time prevented the Channel Islands supplies being continued, but the new port at Richborough had now, to a limited extent, become available and made up for the loss of the other places.

A few figures will illustrate the growing magnitude of the problem.

The tonnage of engineer stores shipped to France in January, 1915, was 10,000, in January, 1917, it was 55,457. For many months at the latter part of the war it averaged over 40,000 tons a month. All this had to be collected after careful inspection, from contractors' works all over the country, piloted through the congested railways to various seaports, and dove-tailed into a shipping programme month by month. Moreover, the stores had to be sent where they were most needed. There were two main depôts in France, and according as the needs were, either, for instance, for the armies on the Belgian front or on the Somme, the stores had to be despatched accordingly. Then there were other theatres of war which, had to be supplied, and the difficulties were increased by the fact that we could not communicate with them so easily and readily as we did with France. However, in December, 1915, a subsidiary base was established at Alexandria and very excellent work was done there by the officer in charge in keeping us in touch with all the needs of the near East.

As the shipping problem increased in difficulty and magnitude it was found necessary to have a suitable storage depôt as near to the docks as possible and there to receive supplies pending shipment. Such a site was found at Abbey Mills in the East of London, near the huge gas works, and there, not only were stores collected, but a certain number of useful experimental trials were carried out. In a war of this magnitude many novelties were brought forward, the efficiency of which it was necessary to prove, and as this in some cases had to be done under conditions reasonably similar to those obtaining in the field, another site was also selected near Surbiton, at Claygate. A disused brick field was hired, and there extensive instructive trials of various types of tunnelling plant, trench diggers, light and heavy ropeways, were carried out for some three years, by officers and men

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unfit for service overseas. These trials disclosed weak points or suggested improvements, and as each was remedied, the improved plant was ordered on a scale sufficient for need in the field.

In order to keep pace with the enormous demands, orders were placed as widely as possible all over the United Kingdom. Many firms took up work to which, ordinarily, they were quite unaccustomed and it was necessary to keep in constant touch with them, advising as to improved designs and processes. These advisory duties fell to the lot of a staff of inspectors, of whom 74 ultimately were employed, and who did admirable work. The total value of the stores inspected and despatched during the war was 32¼ millions, and it may be inferred from this large sum how great were the responsibilities and how serious was the task devolving on the inspectors. Very close record was kept of all despatch. One little incident may be quoted to illustrate this. In the autumn of 1917 the Director of Works in Egypt complained that one out of a batch of pumps delivered in Palestine, leaked owing to faulty packing at the joints. He quoted the identifying number and we were able to at once trace the inspector, date and place of inspection, and to call for an enquiry into the circumstances. Of course, in ordinary practices, one can get a faulty article replaced, but in war one cannot afford to have any failure.

I now propose to give in brief outline some account, necessarily very imperfect, of how the varying fortunes of the war affected the supply of different engineering material.

The retreat from Mons involved the destruction of many bridges, which, in the subsequent advance after the battle of the Marne, had to be rebuilt. The reconstruction of one of these over the Aisne took three weeks with local material. Obviously this was far too long, and consequently we were asked to design and despatch girder bridges which could be quickly transported and easily erected, capable of taking the heaviest loads current in the army, and of spans varying from 12 to 85 ft. Such bridges were designed by F.W. 8 and orders placed for a certain number at once. There were some 300 of these demanded and sent to France in the first year of the war, and special schools for instruction for men to learn the methods of erection were established. In March, 1917, when the Germans retired, blowing up all bridges, these girders were invaluable and (to quote one instance only, among many) a big bridge over the Somme at Brie, which under normal conditions would have taken two or three weeks to restore, was actually completed in four days in the worst winter weather. A special pattern of light bridge rapidly erected was invented by Major Inglis, who in peace time is a professor of engineering at Cambridge. It is unnecessary, I think, to describe at length this remarkable and ingenious invention, as it already has been the subject of papers read at the British Association and re-published in the technical press.

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But I may mention that these light bridges were of special value in the fighting which took place towards the end of the war. Some of them have been erected in Italy and were invaluable in the operations which culminated in 1918 in the Austrian defeat. In Palestine one at least is now spanning the Jordan. It is, perhaps, sufficient to say that this invention was one of the most useful in connection with the work undertaken by the engineers of the new armies.

Early in the war it was anticipated that siege operations might be possible, though we little imagined that they would be on the huge scale which actually was the case. A committee considered the plant necessary for a siege ; and among other items was an outfit for narrow-gauge railways 2½ ft. gauge, of which 100 miles of permanent way, 40 internal combustion engines with corresponding rolling stock, repairing shops complete with various tools and machinery, were placed on order. For reasons which I cannot now explain, this plant was not acceptable in France and so a year later I sent it all to Egypt where it came at a very opportune moment for the construction of the line of defence 6 miles east of the Suez Canal. In fact, one may say that this light railway plant and the water supply plant which was sent at the same time, made possible the Canal defences which baffled the German-Turkish attack and were the first step towards the great victory in Palestine.

As the army in Flanders, after the first battle of Ypres, settled down to the grim winter campaign in 1914–15, the call was for trench pumps, loophole plates, sap-shields, wire entanglements, posts, trench diggers, steel joists for dug-outs, and any quantity of timber. To keep fire and communication trenches dry became a vitally urgent matter, and this country was scoured for any pattern of hand pump, also for power units varying from 2,000 to 9,000 gallons per hour against a low head.

During the first 15 months of the war 15,000 pumps and 250 miles of hose were either sent or being manufactured.

The quantity of timber required was enormous and any stocks found in the towns near the frontier of France were speedily exhausted. Workshops were established in convenient places, and where such shops already existed they were utilized to the fullest extent possible, but very frequently, and more and more as the campaign advanced, local resources were found inadequate and we had to supply, from home, wood-working machinery and all other accessories for workshop equipment. The quantity of articles required in trench warfare made of wood is not very varied but amounts to an enormous total. For instance, I understand that in the first winter of the war the amount of duck boards used in the trenches at any one time would have reached from London to Inverness. Dug-out frames, revetment frames, and other similar articles for ordinary trench use were being

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utilized as fast as they could be manufactured, the daily waste owing to the enemy's fire being enormous.

I shall mention below, the steps which were taken to supply the necessary timber. Meantime, another urgent supply of a different character was in connection with the roads. Thousands of tons of road metal had to be supplied daily, and for this purpose a small fleet of ships was continually plying between the Channel Islands to ports on the Flanders sea border. Many road rollers and millions of gallons of tar were also sent to repair these roads, and in the summer of 1915 special battalions of navvies were enlisted in England for the purpose of supplying the necessary labour.

Deep mining came on about March, 1915, and powerful motor pumps were required to keep the shafts dry; of these the maximum weight of any part was not to exceed 300 lb. and the motors had to be driven by generating sets located in safe positions in the rear. Air pumps for ventilating the galleries, special surveying instruments for laying out the mines, life-saving apparatus, and other special mining stores had to be obtained at the shortest notice. Many demands for mechanical trench excavators and mining machinery came in, and many patterns were tried, but after exhaustive experiments it was found that none were entirely satisfactory and suited to the peculiar needs of modern war.

Concurrently with all these demands for the fighting lines there were vast stores needed for the many miscellaneous services on the Lines of Communication. Hospital accessories of various sorts and laundry machinery were among these. Materials for facilitating the unloading of ships at the ports and the docks at various bases on the English Channel had to be hurried over frequently at very short notice.

Early in 1915 the Dardanelles campaign came on, and the uncertainty as to engineering stores in connection with this venture was one of the great difficulties which we had to encounter. Moreover, misfortune seemed to dog the steps of that campaign in engineering as in other matters. One instance may be mentioned, as it is typical. A complete outfit of water-boring plant had arrived off the coast and was transferred one calm evening to a lighter with a view to being taken ashore at daybreak the next day. The naval transport officer decided not to take it ashore until the morning and during the night a gale sprang up, swamped the lighter, and the whole lot went to the bottom. Language is insufficient to describe one's feelings on the subject.

Lord Kitchener's visit to that region at the end of 1915 was the origin of the Alexandria base depôt above mentioned, and from that time forward this auxiliary base proved of inestimable service, in collecting stores from India, Cyprus, and other parts of the East,

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and at the same time keeping us, at home, fully informed of their requirements from Great Britain.

Meantime, in the winter of 1915–16 preparations were made for a big push on the Somme. It was known that water supply there would be a matter of the greatest difficulty, and early in 1916 very special arrangements were made to send pumps and piping to that part of France and to train the troops in the rapid laying of mains. Ultimately the big push did not come off until July, but when it did take place the arrangements made worked out splendidly. At the attack on one fortified village, for instance, the water mains were laid into the captured village, some miles ahead of the front line, on the same day that the position was taken, and in spite of the many bursts by shell fire, the network of pipes and watering stations was maintained and pushed on all through the fierce fighting of the autumn. By November, 1916, 800 sets of power driven pumps had been supplied and 200 miles per month of 4in. pipes were demanded and delivered.

The supply of timber had by this time become so exceedingly difficult, owing to the shortage of shipping and the requirements in Great Britain—our chief source of supply up to that time being the Baltic—that it became necessary to enter into some negotiation with the French Government as to a supply of timber from forests in their country. A certain amount had already been done by local negotiation, but the demand was far greater than any local supply could afford and it became necessary to make an arrangement between the Governments concerned. I visited the War Office at Paris with some of my colleagues early in 1916 to discuss with the French authorities the questions of road metal and forest timber, and as a result of these negotiations we had handed over to us some forests in the North of France which we worked with our own labour, and various other forests for which Canadian Forest units were specially obtained. Machinery, however, for all these services was required in large quantities—quarry machinery for supplying the roads, and wood-working machinery for sawing the timber felled in the forests. Ultimately the Forest Administration formed one of the special branches of the Royal Engineers in France, but it depended upon F.W. 8 for the supply of its machinery.

The heavy artillery which the Germans brought into use towards the close of 1916 required the provision of deep shelters, and this brought into use the heavy corrugated steel arches known as "elephant shelters" which had to be specially designed and sent over. Several types of tunnelling machinery were tried and after many experiments some electrically-driven machines went to the front to construct deep dug-outs and communication tunnels.

Another urgent call related to the provision of machines for rapidly burying signalling cables which otherwise were quickly destroyed

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by hostile artillery, and the ever increasing wear of the roads demanded numbers of road rollers, many of which had to be requisitioned from local authorities in England as they were not obtainable otherwise. After 1916 the roads behind the front line (5 miles and more from the line of actual operations), were taken over by the newly-formed Department of Transportation.

As the country in the vicinity of the fighting armies was now an absolute wilderness owing to the terrible intensity of artillery fire, it became necessary to provide for hutting the troops in winter. In June, 1916, corrugated steel sheets, which had been already in great demand for the accessories of trench warfare, were now required for housing purposes, and the supplies sent averaged 14,000 tons a month. A new type of corrugated steel hut had been invented by Major Nissen in 1916 and the first lot of 27,000 were delivered in the autumn of 1917. Shortage of steel, and the great demand by other departments for that metal, delayed delivery of the second order of 20,000 until well on in the winter of 1917–18. Demands also for stoves came pouring in and it was with the utmost difficulty, owing to the same reasons of shortage of materials and labour, that we were able to ship 43,000 to France by the end of 1917.

During that year the water supply problem became more and more acute. Although the plant ordered in 1916 aided materially, it was clear that it was not sufficient, and in June, 1917, 150 portable pumping sets and 156 larger plants, suitable for more permanent installation, were ordered. It was found necessary to bore, in many places up to 300 feet, and drilling plant was obtained from America, the water being raised by special pumps and air lifts. The latter called for a compressor and engine carried on a lorry chassis so that the outfit could move from one bore hole to another, filling up successive service tanks. For shallow wells centrifugal pumps were used to deliver from two to three thousand gallons per hour against heads up to 115 ft., while other classes of pumps were used for deliveries up to 12,000 gallons per hour against heads up to 300 ft. Water purifying plants of various kinds were also required, some of them being of a portable nature designed to fit into the ordinary general-service waggon. In addition to all the above, laundry and wood-working machinery, fire engines, destructors, disinfectors, cranes, motors of various kinds, and many other miscellaneous machines were demanded and supplied. A regular monthly supply of all ordinary requirements such as cement, steel sheets, entanglement posts, wire netting, steel joists, etc., was also sent which, apart from all special machinery, alone amounted to about 35,000 tons a month. During the last year of the Boer War the average monthly tonnage of all stores, ammunition, food, clothing—everything in fact for the army—only amounted to 20,000 tons. This figure gives an interesting index of the scale of the two campaigns.

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Turning now to other theatres of war, in the winter of 1915–16, the line of defences east of the Suez Canal required some 80 miles of 4in. steel pipes with pumping plants. These pipes were partly obtained from Holland and some from India, but most came from America. We were fortunate in obtaining the services of an expert in that particular branch of industry who went to America and made the purchases, seeing them on board ship. The enemy got wind of it and tried to intercept the ships, but apparently blew up the *Persia* instead. The whole of the consignment arrived safely, and the line of works in the desert was amply supplied with water. The success of this encouraged the General commanding in Egypt to ask, in July, 1916, if we could arrange for a much bigger scheme, namely the supply of piping 12in. to 10in. and four complete pumping stations across the desert by the caravan road to El Arish on the Palestine border. This was undertaken by the same arrangement as before, with American firms, the expert adviser travelling with the material, which was delivered in the autumn of 1916, and the work was rapidly put in hand so that by February, 1917, water from the Nile in ample quantity was pumped into Palestine through 87 miles of 12in. to 10in. piping. This was the most notable water supply scheme ever carried out in the annals of war. The attack on Gaza which followed was not at first successful, and the summer of 1917 was spent in consolidating our gains, providing new wells and pumps, installing workshops, and making roads. In November Gaza was captured and Jerusalem fell a month later. Water supply through pipes from sources in the Judean hills was one of the first tasks undertaken for the Holy City. Demands for plant and material from England steadily increased. Monthly reports in full detail were sent to me by the Director of Works in Egypt, whose work was admirably organized and executed.

Reports from Mesopotamia were not, however, so easily obtained owing to the lamented death of the Director of Works there. Demands had come in in 1916 for hot water apparatus for the hospitals, for portable huts and bridges of spans up to 60 ft., while the port of Basra was provided with small independent electric power stations for lighting, and with ice plants of one ton capacity. These small installations, however, were found insufficient and in the autumn of 1916 we were called upon to supply Basra with a power station of 1000 K.W. for lighting, for 7,000 electric fans in the hospital, and for manufacturing 20 tons of ice in a day. The first consignment of boilers for this large plant was lost at sea by enemy action, but by strenuous exertions these were replaced in eight weeks and the central supply station was operating in April, 1917. After the Turkish armies were driven out of Bagdad it was decided to encourage the cultivation of crops in Mesopotamia, and as a canal system of irrigation would take too long to develop, demands were sent to the War Office

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for eight powerful pumps and engines as a first instalment, and also for spare parts for some hundreds of pumps and engines of British manufacture which had fallen to the army as prizes of war. It was no easy task, in the absence of detailed information, to obtain all these spare parts, but the matter was accomplished. Further demands for all sorts of agricultural machinery were obtained and despatched in the spring of 1918. The establishment of camps for refugees from Armenia, the Caucasus, etc., necessitated the supply also of miles of piping, disinfectors, refuse destructors, and hospital necessaries of all sorts.

I might describe at some length the supply of the needs of the armies in North Italy, in Macedonia, and in East Africa, but to a great extent it would only be a repetition of what has been previously described for other places. The demands for Italy were met, to a very great extent, from supplies in the depôts which had been established in northern France, but as the nature of the country was mountainous it was found necessary to send certain stores, such as aerial ropeways, which had not been found to be required in northern France. The best pattern of this particular class of plant had been settled after much careful experiment. Some had been sent to Macedonia and others have been more recently despatched to the mountainous frontier of India, where it is understood they have been used in the operations against the Afghans.

The supply of timber to the armies in France, and the organization for working the forests in that country, assumed very great dimensions towards the close of the war. Canadian lumbermen were employed in large numbers and large forests were taken over from the French Government. Wood-working machinery of all sorts had, however, to be supplied, and in most cases the various armies and corps established workshops of their own. In Egypt, where there was no means of obtaining timber in the country, it was found necessary to obtain timber from India, but the difficulties of shipping and the cost of the timber so supplied were so great that it was thought desirable to look about for some other source of supply. Ultimately, arrangements were made for utilizing the forests in Cyprus and a certain number of Canadian lumbermen were sent to that island for the purpose of making the best use of the forests which existed there. The timber so supplied was sent to the depôt at Alexandria which furnished materials for Macedonia and all the operations in Syria. Mesopotamia obtained its supplies from India.

Though I have mentioned only a few samples of the varied classes of engineering plant sent from this country during the war, I think I have now said enough to indicate how the problem of engineering supplies to an army differs from the supplies of food or of ammunition, or clothing, or any of the other ordinary munitions of war; how it varies with the peculiarities of the

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country, of the weather, and of the nature of the operations; and above all, how vitally important it is that there should be the closest co-operation between the directing staff in the field and that at home. This last reason is why I resisted every proposal to hand over the work to a new department, not because one wished to claim any superior knowledge of engineering, or any special administrative capacity, but because of the close personal relations which I had—and my staff had—with the leading engineers in the field. We enjoyed the confidence of Sir Douglas Haig and his army commanders, whom I used to consult freely when I visited France (which I generally did before a big push came on), and I felt that with any new organization there might be a risk of failure which would be fatal to success, and which we could not afford to risk in this death and life struggle. When it was proposed, therefore, in 1917, on the formation of the Department of the Surveyor General of Supply, to take the whole of the supply of engineering materials out of our hands and put it under a new civil organization I represented the case fully to Mr. Andrew Weir, now Lord Inverforth, pointing out—what I think was a new consideration to him—that the regular and adequate supply of engineering plant was so intimately connected with military operations, that certain military responsibilities devolved upon the supply officer which he would have to accept if he took over the whole task. I think he quite saw my point and stated that all he desired was that the working and organization should be subject to his scrutiny as to whether or not sound business methods were being applied, and whether the country was getting full value for its money. He took steps to assure himself on this point, sending one of his principal staff to investigate in full detail the whole of the working. Being quite satisfied on the subject he left matters as they were, only insisting—rightly—that I should keep him informed of any alterations or improved steps which were being taken.

The description which I have endeavoured to give above has failed in its purpose if it has not proved to you how great a field there is in war for all classes of engineering, and how great have been the services of civil engineers of all special branches in this country. I think you will recognize that in this, as in many other national matters, we cannot stand alone, and it is by playing the game together, by each contributing his own share, and by all working in harmony, that great results, such as the victory over the enemy, can be accomplished.

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CONTROL OF ENGINEER WORK IN WAR.

(*A lecture delivered at the S.M.E., Chatham, by* MAJOR-GENERAL P. G. GRANT, C.B. C.M.G.).

Synopsis. Co-operation Essential—Pre-War Engineer Control—Early War Engineer Control—Later Developments Engineer Control—Engineer Control at end of War—Military Policy Dominates Engineering—Re-action of Engineering on Policy—Scope of Engineer Control—Methods of Engineer Control—Duties of Engineer Staff Officers—Delegation to Engineer Staff Officers—Classification of Work—Comparison of Methods of Engineer Control—Final Remarks.

Co-operation.—F.M. Lord Haig, reviewing the Work of the Arms and Branches of the British Forces during the War, said in his Final Dispatch :—

" An intelligent appreciation of the other man's job is the first essential for successful co-operation."

Taking this maxim to heart we engineers must study the work of other arms and branches as well as our own. And we must not let ourselves become so engrossed in our own point of view that we fail to realize that of others. So we shall go far to secure successful co-operation between the R.E. and other arms. But besides this we must have successful co-operation of engineers with engineers, if we are to develop our full power. However efficient we may be, individually or as units, we shall not produce the best co-operative results if the engineers of armies, corps and divisions work in separate compartments, each entirely free of any higher engineer control. I shall try, therefore, to explain how the technical control exercised by an E.-in-C., Chief Engineers and C.R.E.'s enables all these groups to act in combination as parts of a single engineer organization though each group remains under the command of its own particular formation.

Pre-war Control.—In pre-war days the " Division " loomed in the eyes of the British Army as a very large formation. The R.E. certainly did not think of war in terms of armies and corps, any more than the bulk of the Army did. So we devoted much thought to the functions of a Divisional C.R.E. but little to those of a corps or army C.E. and still less to those of an E.-in-C. In fact there seemed to be little necessity for higher engineer control in those days.

Early War Control.—It is not surprising therefore that in the early days of the War, the functions of the E.-in-C. and C.E.'s in regard to

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the engineers of lower formations were not understood either by the army in general or the R.E. in particular. A prevalent impression was that they advised the G.O.C. of their formation upon engineering matters when their opinion was requested and that they regulated the issue of certain engineer stores. Their position was regarded as one of considerable dignity and much leisure. The engineers of formations considered themselves to be self-contained groups with little or no responsibility in engineering to anyone beyond the G.O.C. of their own formation. Too much interest in their doings by the C.E. of a superior formation was to be deprecated. If a crisis arose, such as a shortage of sandbags, he might be useful, as it was up to him to produce them. Any other assistance he might be able to give was gratefully received, but not much was to be expected. *Vide* War Establishments 1914.

Later Developments.—Later on as the British Army grew in size, and especially when offensives on a large scale began, armies and corps became the only more or less permanent institutions in a given area. Through them flowed a constant stream of divisions attacking or recuperating after heavy lossess. So it became increasingly necessary for the larger formations to take control of many matters formerly left to divisions in order to secure continuity of policy. This applied equally to engineering. As a result the functions of C.E.'s expanded. They were expected to get much more grip on the engineering work of their areas, and to turn the engineering picture into one connected whole, instead of there being a series of poorly developed snapshots of jobs ever starting but never finished. Lack of continuity was producing disappointing results in out-turn of work compared with heavy expenditure in time, labour and material. C.E.'s in the eyes of their Generals at all events, soon ceased to be regarded as mere advisers and storekeepers. They were expected to exercise some measure of control over the engineering of lower formations and, besides, to undertake themselves work of all kinds extending far forward into the battle zone as well as far in rear of it.

For example in 1916 during the battle of the Somme, a Corps Chief Engineer might find himself held directly responsible for:—

(1).—Constructing and completing by a given date three pairs of up and down communication avenues, each about 1,200 yards long, trenchboarded throughout, provided with splinter proof runner posts at 200-yard intervals and debouching on to the front infantry support trench.

(2).—Watching and reporting on the conversion by Divisions of an old German trench into a "Second Line."

(3).—Constructing a new "Third Line" wired throughout and provided with tunnelled dugouts for M.G.'s, etc.

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(4).—Recovery, repair and upkeep of the roads through the battle zone upon which the whole heavy artillery ammunition supply depended.

(5).—Sinking and equipping with power-driven pumping machinery tunnelled wells in the shelled zone, in readiness for the pipe lines which were pushed on following up each successive advance.

(6).—Construction and maintenance of reservoirs, horse watering points, and water cart filling points with miles of pipe lines buried 3 ft. below the surface.

(7).—Buildings, roads and water supply for several Casualty Clearing stations.

(8).—Construction of approach roads and "Cours" for ammunition and other rail heads.

(9).—Buildings, water supply, etc., for aerodromes and miscellaneous army and corps units and departments, and corps workshops.

At this period of the war the staff of a Corps C.E. normally consisted of 1 staff officer and 3 field engineers, and he probably had permanently under his orders

3 A.T. Cos. R.E.
2 or 3 Tunnelling Cos. R.E.
1 Co. of a Labour Bn. R.E.
½ M.T. Pontoon Park
1 Infantry Labour Bn.

supplemented by a varying number of Field Squadrons and Cos. R.E. and working parties drawn from miscellaneous units such as the Special Brigade R.E., the Corps Cavalry, Corps Cyclists, Squadrons of Cavalry, etc., etc., and as much horsed and lorry transport as he could persuade the D.A. and Q.M.G. of his Corps to place at his disposal.

Control End of War.—Under the pressure of such circumstances all C.E.'s of armies and corps evolved their own systems of engineer control, but its extent in any particular case was a variable quantity up to the end of the War, dependent upon the personal and many other factors. No standardized system of control was imposed so that there was presumably diversity in the 5 army systems, 18 corps systems and 50 to 60 divisional systems. Many disadvantages are inherent in such lack of standardization. I will cite one example: officers, units R.E., and whole formations moved constantly from one command to another. On each occasion a new set of engineering "ropes" had to be learnt, *e.g.*, "What is the procedure for replacing pontoons in this army," "How does this corps run roads," "How are the pioneers dealt with in this division," etc., etc., etc. Some may regard standardization as stifling initiative and pernicious

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in other ways, but remember that variations in procedure cause loss of time and increase the strain on individuals. Time is a factor of the utmost importance in war, and increased strain on hard worked individuals produces increased casualties in *personnel*. Doubtless there were excellent reasons preventing clear definition during the war of the engineer control to be exercised from G.H.Q. and H.Q.'s of armies and corps and divisions. Also the introduction of standardized methods of effecting such control. Presumably the omission will be rectified in due course by the issue of an official manual regulating both these matters. If in sufficient detail such a manual will be a useful guide for commanders and staffs in handling their engineers, and to the E.-in-C., C.E.'s and C.R.E.'s in the exercise of their functions..

Policy Dictates Engineering.—It is the military policy, programme or plan in force for the time being which dictates the engineering policy to be pursued. The converse can only hold good in very exceptional circumstances. Nevertheless, engineering considerations are nearly always so important that they cannot be safely ignored when some military operation or course of action is being designed.

Influence of Engineering.—If this view is accepted the following principles should also be accepted. :—

(*i*).—The engineers should receive information in sufficient time to be able to express a considered opinion upon the engineering aspect of a projected military scheme

(*ii*).—That opinion should be duly taken into account before the scheme is approved for action.

(*iii*).—The engineers should draft the engineer instructions involved.

Unless these principles are conceded and acted upon, control of engineering in war is rendered difficult, and success in the engineering part of a scheme cannot be guaranteed. At the same time, we must not be disappointed when our views do not always carry all the weight which we think they should. The outlook of a G.O.C. formation is higher and broader than ours. He has to balance our pros and cons against others unknown or imperfectly known to us, and will often come to a decision adverse to our views. It is for us in such a case to accept his decision loyally, and do our utmost to carry out the engineering part of his scheme to a satisfactory conclusion.

Scope of Engineer Control.—Clear definition of the matters which can be appropriately assigned for control in the engineer channel is necessary. They are :—

(*i*).—Strict adherence in a lower formation to the engineering policy prescribed by the command of a higher formation.

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(*ii*).—Strict adherence to the order of urgency prescribed by that command.

(*iii*).—Non-diversion of labour, materials, or transport to engineer work outside the prescribed policy—*except* in case of urgent tactical necessity.

(*iv*).—Strict adherence to standard specifications and plans.

(*v*).—Issues of engineer tools, plant and materials.

It should be clear from the foregoing that engineering control deals only with technical matters, supplementing the chain of military command so as to ensure that all engineering in progress is in conformity with the expressed will of the commander. Units R.E. cannot of course be moved under engineer orders—movement orders must be issued by the staff. But allotments of engineers. labour, and transport should be made on engineer recommendation. This amounts to a 6th " Principle."

Methods of Control.—Effective engineer control within the limits above defined can be achieved by a combination of the following :—

(*i*).—Engineer circulars.

(*ii*).—Standard specifications and designs.

(*iii*).—Engineer instructions.

(*iv*).—Inspections.

(*v*).—Reports.

(*vi*).—Conferences.

(*vii*).—Correspondence

Circulars are much like standing orders. Each deals with some specific matter which is not confidential or secret, *e.g.* : " C.E.'s staff—distribution of duties," " Periodical Returns and Reports," " Issue of Engineer Stores," " Heavy Bridge Projects," " Water Supply Projects," " Replacement of Pontoon Equipment," " Issues from Army Workshops," etc., etc. They are a guide to procedure. They must be revised to date constantly. New circulars regulating procedure will be found requisite from time to time. Circulars are issued to H.Q.'s engineers of formations with spare copies. It is essential to file them in an engineer circular file, kept always to hand for immediate reference.

Standard specifications deal with matters such as designs for:— " Horse Watering Points," " Water Cart Filling Points," " Lay-out of Sedimentation and Filtration Beds," " Mobile Water Points," " Tunnelled Dugouts Battalion and Brigade H.Q.'s," " Tunnelled M.G. Dugouts," " Plank Roads," " Accessories for Hutments," " Engineer Railheads," " Accessories for C.C.S.'s," etc., etc. Enforcement of strict adherence to standard specifications and designs is just as important in war as in peace. The fewer the patterns in use the quicker will work be done and the cheaper as regards expenditure of time, labour and material.

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Engineer instructions are secret. They deal with the engineer work of a specific projected operation or possible contingency. They are issued in numbered copies to H.Q.'s of formations at the same time as issued to H.Q. engineers of those formations. They quote the G.S. orders or instructions on which they are based. If it is desired to issue an engineer instruction not definitely based on such orders or instructions concurrence of the G.S. with the proposed engineer circular must be previously obtained.

Inspections should be personal visits of the C.E. himself as far as possible, but he cannot cover all the ground in a large area sufficiently often, so much inspection work has to be done by members of his staff who make verbal or written reports as necessary. Adequate motor transport must be allotted to engineer H.Q.'s of all formations if these important duties are to be performed efficiently.

Reports should be cut down to the minimum. It is better to see things for oneself than to read about them. Certain progress reports however cannot be dispensed with. Sometimes, as during an advance, reports showing the restoration of roads and bridges must come in daily in order that the H.Q. engineer situation map may be kept up to date. Other progress reports will probably deal with matters like "Defences," "Bridge and Road Crater Mines," "Water Supply," "Pillboxes," "Tunnelled Dugouts," etc., etc. Standard symbols to be used in maps should be prescribed to facilitate compilation at H.Q., also standard forms and headings in written reports.

Conferences of C.E.'s, C.R.E.'s, etc., are best limited to explanations regarding the engineering to be carried out during a projected operation, or of some possible contingency. Unless this is their *raison d'être* large conferences are apt to degenerate into rambling discussions arriving at no decision. Specific points requiring elucidation can generally be settled better at a small meeting of the few concerned in that particular matter. A record of decisions made at a conference must be issued promptly to those concerned unless the issue of an engineer instruction follows the conference. C.R.E.'s can order the attendance of their unit commanders but C.E.'s must obviously arrange attendance by request.

Correspondence includes the telephone, telegrams, letters. Telephone calls from a lower formation should be made in the first instance on the particular officer of the superior engineering staff concerned in the matter in reference. If not satisfied the C.R.E. or C.E. should call up the C.E. by name. This procedure acts as an S.O.S. signal or safety valve for use in emergencies. Letters are apt to fade into oblivion very rapidly in war. Matters required for future quick reference are best embodied in circulars.

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Liaison must not be overlooked. Touch should be kept, not only with R.E., but also with commanders, staffs, and others, by informal visits to their H.Q.'s. Important matters come to light on such occasions which may be otherwise overlooked. It is also much easier to conduct business satisfactorily between individuals personally acquainted with each other.

Duties of Engineer Staff.—Effective engineer control is facilitated by careful distribution of duties among the members of one's staff, and as already stated it is important that this distribution should be made known to the engineer staffs of lower formations by the issue of a circular. A C.E. or C.R.E. requires time to ponder, to foresee and to plan ahead. He must also be out and about constantly or he will be out of touch with men and matters. To secure this leisure he should leave details to his staff, dealing, himself, only with the larger questions and matters of policy. He must give full power to his staff to deal with ordinary business on their own responsibility. The senior engineer staff officer should act as deputy C.R.E. or C.E. Deputies should know everything there is to know about current questions, and see, as far as possible, everybody and everything that their chiefs do. They should know their seniors' views and intentions and have full power to act for them in their absence except in questions involving a new policy which should be reserved for their C.E. or C.R.E.'s decision unless too urgent to await their return. The other members of an engineering staff should be regarded as the administrative heads of their respective branches. If there is a bridging officer for example, he discusses projects with the C.E. or C.R.E. concerned, makes recommendations to his own C.E., and when the project has been approved he deals with all subsequent details without further reference to his C.E. He is not an executive officer, and should never have engineer units placed under his orders, though he should constantly visit work in progress, and act generally " for the C.E." verbally and in writing. The water supply officer's duties are similar, viz.: Examination of W.S. Projects; Recommendations; Regulation of Details; Inspection of Work in progress, but no executive charge. A C.E. or C.R.E. can easily keep touch with the work proceeding in the different branches of his office by glancing daily at the office copies of letters and messages dispatched and by short interviews with the members of his staff. A C.R.E. of army or corps troops is an executive officer. He commands and controls the work of his own units and should have his own area, workshops and stores depôt, in stationary warfare. He should be in executive charge of the army workshops and parks, taking orders as regards policy of manufacture from the C.E. personally and orders as regards issues from the S.O. for stores as representing the C.E. Situations sometimes arise in which it is necessary for a C.E. to take under his own

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direct control engineer units nominally at the disposal of his C.R.E. army or corps troops. The C.R.E. may not be able to supervise work because it lies so far forward and he has much work in progress in his back area. In such a case the C.R.E. and the units concerned must be informed that the latter are temporarily placed under the C.E.'s direct control. During the war engineering staffs and C.R.E.'s of army and corps troops could seldom develop their full power of work owing to lack of personal motor transport facilities.

Delegation.—The only way in which a C.E. or C.R.E. can avoid the paralysing effect of masses of detail is by delegating definite responsibilities and powers to his staff and to his C.R.E. corps or army troops. No officer R.E. can be efficient unless he knows how to trust his subordinates and work them to their full capacity. At the same time he must be careful to keep the main threads in his own hands otherwise "delegation" degenerates into a condition of affairs commonly called "The tail of the dog wagging its head."

Classification of Work.—The old slipshod statement that work "will be carried out under engineer supervision" is quite out of date and should never be used when co-operation of engineers with other troops is meant. Works in the field are either

(*a*).—Engineer jobs, or
(*b*).—Contract jobs.

By the latter I do not refer to civil contracts such as are entered into on the L. of C. The difference between the two is that in an engineer job the R.E. are entirely responsible, whereas in a contract job the commander of a brigade, a battalion, a company, or some other unit is entirely responsible. Portions of a big job will often have to be executed by both these systems simultaneously. Erection of a heavy bridge may be cited as a typical example of an engineer job. Here the engineers do all the technical work, having under their direct control any auxiliary labour required for carrying material and gear to site and so forth. Tunnelling is another example.

A typical contract job would be the construction of trenches and entanglements in a rear defence zone. The R.E. may perhaps roughly indicate by a furrow in the ground, the approximate location of the trenches and approaches. They may perhaps peg out the location of tactical wire swept by M.G. fire; dig a sample length of model trench and indicate the style of revetting. But some unit commander should be entirely responsible for exact siting of trenches and for pushing on work in accordance with a plan and specification provided for his guidance. Officers R.E. would visit the work from time to time to assist in any way possible. A few sappers might also be placed at the commander's disposal to work under his orders. Meanwhile the units R.E. detailed to work on the scheme push on

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with command and observation posts, tunnelled M.G. emplacements, concrete pill-boxes, and so forth. Any supplementary labour working with them would be entirely under engineer orders. Before a C.E. or C.R.E. decides how a certain job should be classified he must appreciate correctly the amount of engineering involved. The classification allotted must be clear to those concerned. Haziness on the subject leads to divided responsibility, friction and frittering away of one's engineers. For example, an unskilled labour unit, plus seven or eight sappers cannot make a job of repairing a badly shell-pitted, water logged road. If work is exposed to shell fire it is desirable to make it an engineer job even though it seems hardly necessary from the engineering point of view. In such circumstances the R.E. have a naturally steadying influence upon the labour units that may be working with them. They have *esprit de corps* behind them.

Comparison of Methods of Control.—The value of well organized engineer control and co-ordination may perhaps be shown somewhat more clearly by comparing an earlier and a later stage of development of army engineer control. An offensive is projected in each case. In the earlier example we find something of this kind. A.H.Q. operation orders and instructions hardly refer to engineering. The C.E. is quite ready as regards certain work, which will be under his direct control—but he is opposing an agitation by a certain branch to place some of his engineer units under their orders forthwith days before " zero." Such proposals are apt to crop up repeatedly, to the disgust of any C.E. or C.R.E. who appreciates the A B C of engineer control. The C.E. is not in agreement with the arrangements of some C.E.'s of corps, especially a case in which labour provided for engineer work has been handed over for ammunition supply work. Co-operation as between divisional, corps, and army engineers relieving each other on partially completed work seems to be somewhat hazy. Some C.E.'s of corps know very little about the engineering programmes of their divisions. *Liaison* work, right and left, seems weak, especially in the divisions. One division will use its engineers for the construction of strong points under brigade arrangements. Another will devote them to improvement of roads and communications. The next proposes to employ them on strong points and improvement of communications under divisional control. There are different policies all along the line. The corps engineers are to be chiefly employed on road restoration but not in close touch with the army road engineers, so that the latter express fears as to whether the work of the corps engineers will accord with their practice when they come to take over from them as the advance proceeds. Briefly put, we may say that the separate compartment system is in full swing and co-operation of engineers with engineers leaves much to be desired. In the later example the engineering

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picture is clearer. A.H.Q. staff instructions prescribe that restoraation of communications is to be first in order of engineering urgency and a map has been issued defining certain roads as army priority roads, viz., roads which must be made fit for heavy traffic promptly as the advance proceeds in order to secure lorry routes for supply and ammunition services, etc. From this map it has been possible to decide the bridges which have to be restored. Heavy bridge projects have been prepared by corps and approved by C.E. army who has had the materials and erecting gear sent up from the base direct to C.E.'s of corps and supplemented their transport by certain special army bridging lorries and M.T. and horsed pontoon wagons. An army Engineer Instruction has been issued which reads somewhat as follows :—

With reference to G.S. Secret Instruction — of —

Divisional engineers are responsible for clearing army priority roads of obstructions and rendering them fit for horse drawn traffic. Temporary bridges must keep clear of alignment of permanent bridges to be erected by corps engineers.

Corps engineers are responsible for further clearance of A.P. roads, including road-side drains, water courses, and for filling craters. They will make these roads fit for lorries and heavy artillery, using any material available locally such as timber and masonry from buildings, and road slabs when this method is unavoidable. They will also undertake erection of all heavy bridges on these roads.

Army engineers are responsible for complete restoration of A.P. roads using road metal and rollers.

Forward boundary of army road engineers will move forward from day to day so as to be 10,000yds. from the front line shown on the daily army situation map.

It must be noted that though specific road and bridge tasks have been assigned in the foregoing instruction, which must be performed, the corps and divisional engineers will certainly have other road and bridge tasks necessary for tactical reasons. In practice tasks are not definitely allotted until the whole engineering situation has been thrashed out and distribution made to the best advantage of the labour, transport and material available. Corps and divisional commanders will, therefore, have had an opportunity for considering whether their engineers are likely to be overloaded by the tasks proposed to be allotted to them for army reasons, and, if necessary, representing their case for modification of plan or increased engineer assistance. Before passing on we should note the necessity for keeping in each formation a reserve of engineers and material to meet unforseen contingencies; some labour and transport should also be kept in hand if possible.

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Final Remarks.—Summing up to the subject of the lecture I think that efficient Control over Engineer Work in War by Engineers-in-Chief, Chief Engineers and C.R.E.'s, in their respective spheres depends upon the following :—

(*i*).—Possession of that intelligent appreciation of the other man's job which Lord Haig considers to be essential.

(*ii*).—Adequate previous experience of engineering under varied conditions.

(*iii*).—Clear official definition of their responsibilities.

(*iv*).—Standardized methods.

(*v*).—Due delegation of duties.

(*vi*).—Adequate transport for engineering staffs.

(*vii*).—Cordial relations between the many individuals of high and low rank in all branches of the service who can do so much to ease one another's burdens if mutual goodwill subsists.

ESTABLISHMENTS

H.Q. R.E.

1914		1918
1 Brigadier-General.	G.H.Q.	1 Maj.-Gen. 2 Brig.-Gens. 7 Lt.-Colonels. 5 Majors. 6 Capts. 1 Lieut.
1 Colonel.	Army H.Q.	1 Maj.-Gen. 2 Lt.-Colonels. 4 Majors. 2 Capts. 2 Lieuts.
1 Colonel.	Corps H.Q.	1 Brig.-Gen. 1 Lieut.-Colonel. 2 Majors. 1 Captain. 2 Lieuts.
1 Lieut.-Colonel. 1 Capt.	Div. H.Q.	1 Lieut.-Colonel. 1 Capt. 1 Sergt.-Major.

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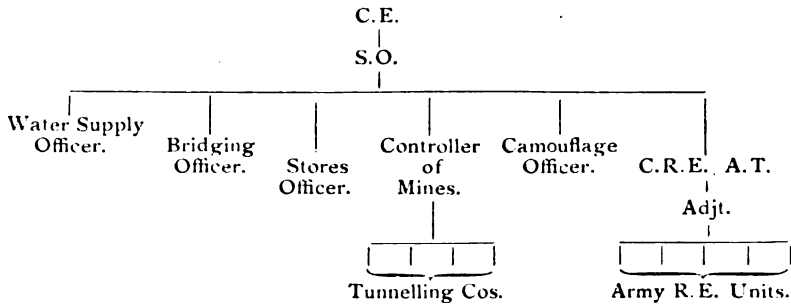
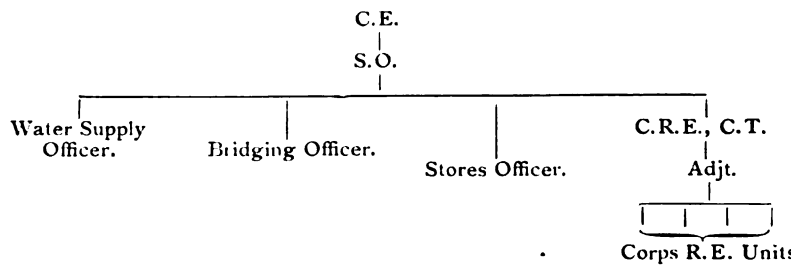
ENGINEER STAFFS.

1918.

ARMY.



CORPS.



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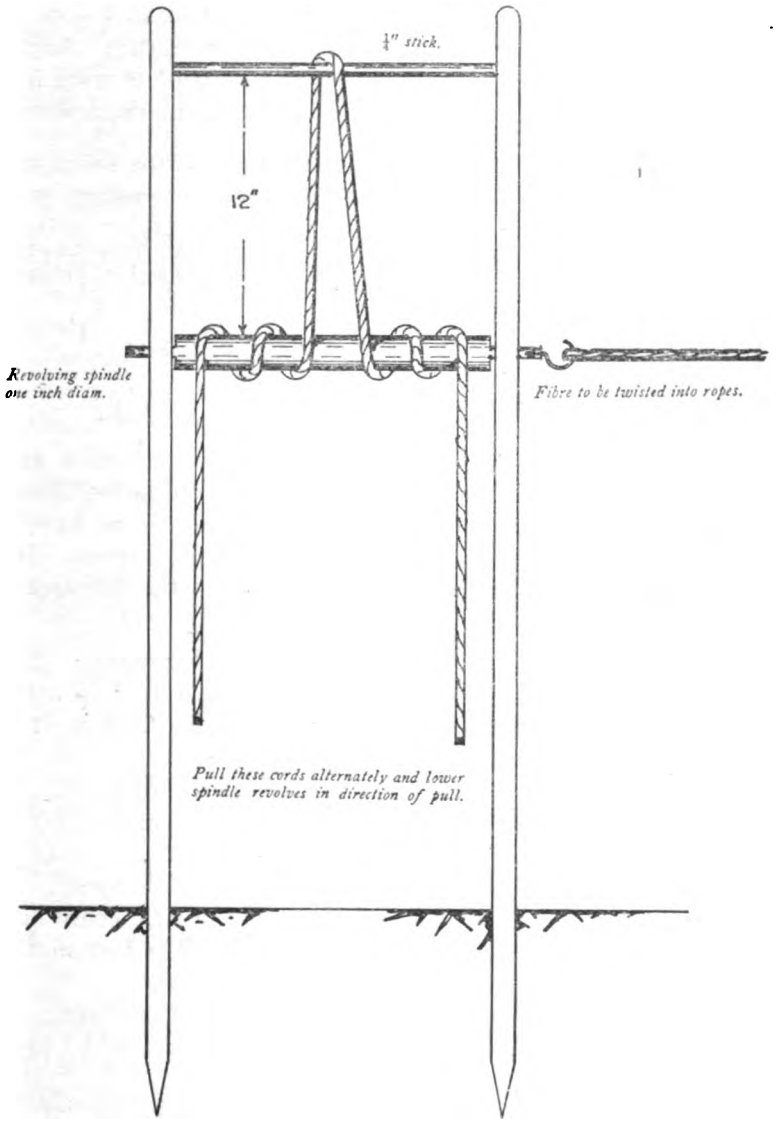
A METHOD OF TWISTING ROPES.

Contributed by MAJOR L. E. HOPKINS, O.B.E., D.S.O., R.E.


¼" stick.
12"
Revolving spindle one inch diam.
Fibre to be twisted into ropes.
Pull these cords alternately and lower spindle revolves in direction of pull.

The above sketch represents a simple Indian arrangement for twisting ropes which is not only useful but also an interesting mechanical contrivance. It is used by Indian jute cultivators.

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THE GERMANS AND CAMOUFLAGE.

"As regards concealment from aeroplanes (Fliegerdeckung) we had learnt as good as nothing (in peace time). Even in the war we followed haltingly and hesitatingly behind our adversaries. Actually, we only learnt 'camouflage'" (the French word is used in the original) "from the English,* after our losses had made us wise."

GENERALMAJOR G. VON GLEICH
in *Die alte Armee und ihre Verirrungen* (p. 19).

* This bears out the statement that the first German book on camouflage was a translation of the British text book captured in autumn of 1917.

TRANSPORTATION WITH THE B.E.F.

SINCE the publication of Colonel Sir S. D'A. Crookshank's article in the *R.E.J.* for November 1920, a portfolio of ten plates, illustrating the article, has been received from India. This has been deposited with a copy of the lecture in the R.E. Library, Horse Guards, where it may be seen on application to the Librarian.

The following is a list of the plates :—

Plate (I). Cross Channel Train Ferry, Calais Terminus. Elevation showing T.F. Steamer (1, 2 and 3) in berth.
,, (II). Cross Channel Train Ferry. Midship Section of T.F. Steamers (1, 2 and 3).
,, (III). Graph.—Total Imports and Exports, 1917–18.
,, (IV). Graph.—Imports, including traffic carried by C.C. Barges, analysed between traffics.
,, (V). Graph.—Loaded Trains run for British Army.
, (VI). Graph.—Loaded Train kiloms. of British Army Traffic compared with that hauled by R.O.D. Locomotives.
,, (VII). Map of Railways in British Army Area.
,, (VIII). Graph.—Light Railways. Tonnage Conveyed.
,, (IX). Graph.—Light Railways. Analysis of Tonnage Carried.
,, (X). Sketch Plan of Transportation and Distribution on a Battle Front.

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THE FUTURE OF PERMANENT FORTIFICATION.

By BRIG.-GENERAL J. E. EDMONDS, C.B., C.M.G.

THE first article in the *Revue Militaire Générale* for September is entitled "L'avenir de la fortification permanente"; the author merely signs himself Général X, but its prominent position in a magazine, whose *Comité de patronage* consists of twenty-one of the most famous French generals, headed by Maréchal Joffre, is sufficient voucher for his claim to be heard. Besides, the custom of writing under *noms de plume* is far more common in France than in Britain. General Palat wrote for years under the pseudonym of Pierre Lehautcourt, and recently General Cornulier-Lucinière published a book on the action of the French cavalry under that of J. Héthay.

In any case the article contains a store of useful ammunition for anyone who wishes to advocate the expenditure of national funds on fortification. For France and Belgium, however, the question is one of actuality. The characteristics of nations remain constant through many centuries, and Prussia, we may be sure, will not submit to remain the under dog now, any more than she did after 1806.

The author recalls that when the question of defences on the Meuse, involving considerable sums of money, was raised in Belgium, von Moltke the elder said:—"As regards Germany it is unnecessary that Belgium should make the sacrifice." King Leopold II., however, who knew a great deal about Prussian mentality, persisted in the project, at the risk of compromising his popularity with his subjects. General X considers that "the Belgian fortifications completely fulfilled their mission of serving the general interests of the Allies quite as much as the interests of Belgium."

The story of Liège is well known and the name of the gallant engineer officer who defended the place, General Leman, will for ever live in history. Attacked by *coup de main* on the 5th August, 1914, the last fort surrendered only on the 17th. The Germans, says the author, lost before Liège 42,000 men, and thirteen days. The latter claim is perhaps a little exaggerated. The heads of von Kluck's main columns are shown on his map* as abreast and north of Liège on the 17th; allowing time for the concentration of his army on the frontier and for two marches, they could hardly have

* See *The March on Paris*. Translation published by Edward Arnold, price 10s.

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been up to Liège, supposing there had been no opposition, much before the 6th or 7th. Undoubtedly the defence of Liège gained ten or eleven days. And we may feel certain that General Leman's 30,000 men of the garrison and 3rd Division, could not have opposed General von Emmich's 130,000 men for that length of time in the open field; far less could the Belgian commander have withdrawn the division practically without loss, and inflicted 42,000 casualties on the enemy, had there been no fortifications.

As regards Namur, General X makes still greater claims. He admits it is true that after a bombardment of only two days the place was at the mercy of the attacker; but the Germans were not in a position to open the bombardment with heavy howitzers until the 21st August, although their advance troops appeared before the fortress on the 5th. The last fort capitulated only on the 27th. General X claims that there was a gain of time of 21 days. Here again a small correction must be made; for although the troops of von Bülow's army had not to make a march through a defile like the town of Aix-la-Chapelle, as the German First Army did, yet the heads of the main columns which passed by Namur on the 22nd August could hardly have reached that place, if unopposed, before the 7th or 8th August.

The Antwerp fortifications proved of even greater value than those of the Meuse. Until the end of September they sheltered the Belgian field army, and detained some 150,000 German troops. The author might have added that Antwerp kept employed the III Reserve and IX Reserve Corps, which according to plan* were detailed to march to the coast in August, 1914, "direction Calais." The two sorties made by the Belgians during the Le Cateau and Marne battles were not without important results in keeping at least two German Corps from the decisive front.

The actual siege of Antwerp lasted from the 28th September to the 10th October; the exceptional material required for the bombardment could not be accumulated before the end of September. Thus the total amount of time gained by the Belgian fortifications was two months. The rôle of the great zone of fortifications on the French eastern frontier is too well known to need description here. Built in the seventies from the projects of General Séré de Rivière of the Engineers, they had by 1876 the effect, as we now know, that von Moltke framed his plans to attack France through Belgium. In 1889 experiments carried out by the French at Fort Malmaison, with melinite, indicated that all the casemates and cover must be reconstructed with ferro-concrete. The Government refused to provide all the necessary credits, and such money as was made available was devoted to improving the four great fortresses of Belfort,

* See Von Hausen, *Marnefeldzug*, p. 244.

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Epinal, Toul, and Verdun, to the exclusion of the forts of the Hauts de Meuse, and of course those of the northern frontier. Some further experiments with 10-inch (270 mm.) shell against Fort Saint-Antoine seemed to throw doubt on the conclusions drawn from the Malmaison experiments, and in view of the enormous amount of ammunition that it was considered the enemy would have to bring up to effect important results, and the uncertainty of hitting, the Government seized the pretext to reduce the vote for fortification still further. They were supported by the General Staff, " in whose mind "—even under General Joffre, an engineer officer—" the questions of fortification appeared to occupy a place more and more secondary." The results achieved by the Japanese at Port Arthur had no influence; the few officers who pointed out the great effects achieved with 28cm. howitzers against shell-proofs designed to resist 21cm. could not obtain a hearing. From another source we know* that at Belfort only a third of the forts had been remodelled when hostilities opened in August, 1914, a third were under reconstruction, and a third still untouched. How far this state of things obtained at the other great fortresses is not known, but it appears that there was but little if any ferro-concrete at Verdun.

General X quotes a number of instances to show the attitude of the higher authorities in France towards fortification. In 1905 in a mobilization scare, hasty measures were taken to provide reserve ammunition for Verdun, as it was found that the credits allotted for it had been diverted to other purposes. In 1907 when the Governor of Maubeuge asked for some howitzers, he was informed by the Inspector-General that the place was " only expected to hold out for a few days from the beginning of mobilization until concentration of the armies was effected." In 1912 Verdun was refused guns carrying 15 kilometres " for the reason that observation at that range was too uncertain." The governors of the fortresses were selected from generals " judged not competent to command divisions in the field." Finally when the Président du Conseil and the Minister of War visited one of the great fortresses in the east of France, the Governor made a great attempt to bring the state of the defences to notice. As the Minister of War was going into lunch he found the way barred by the Governor who said, " M. le Ministre I must speak to you about this fortress. Urgent matters are being held up. They have been a long time under consideration, but I cannot get any decision from the ministry." " Let me pass," said the Minister. " I must go; my afternoon is all planned out." Actually the afternoon was spent in an " excursion touristique."

When the field army took over Verdun and it became a " région

* General Thevenet (Governor of Belfort), *La Place de Belfort*, pp. 3–4.

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fortifiée" instead of a fortress, the organization of the place was completely upset, to General X's personal knowledge. The permanent garrisons of the forts were abolished—with the result that the Germans walked into Fort Douaumont without opposition, and found only a barrack-warder there. When the plan of the fort was asked for with a view to its recapture it was discovered that the archives had been sent to the interior of France and the plan could not be found. At Fort Rozellier the ammunition for the flanking guns was found to be "drill" with wooden projectiles; the drawbridge could not be raised because the telephone wires of the central exchange ran over it, and the lifting gear was broken. At Fort Vaux the tanks of drinking water were found empty when it was attacked by the Germans, as Commandant Raynal, its defender, has already told us.*

When the Germans attacked Verdun in February, 1916, "the forts did not stop the advance of the enemy because their permanent garrisons had been withdrawn. The troops retiring walked past these works which were in a perfect state and empty; they did not enter them. The Germans, who followed closely, occupied them and stayed in them."

The author does not point out, except as regards Antwerp, that the fortresses detained a considerable number of German troops:—Givet, the 24th Reserve Division which only came up to the front during the battle of the Marne; Namur, the XI Corps and Guard Reserve Division till the 25th August; Maubeuge, first the IX and VII Corps, so that they were absent from the battle of Le Cateau, and afterwards the VII Reserve Corps, etc. Had La Fère, Rheims, and Laon been defended, the German forces at the Marne would have been reduced by the troops, probably some six corps, required for the first investment of those fortresses.

General X does not tell us either how the Fort Camp des Romains in the St. Mihiel salient was lost, though he mentions its capture. It appears from a recently published book,† that as the French Third Army advanced in pursuit northwards after the battle of the Marne, German troops from Metz slipped in behind it, into the salient, and by assault without preliminary bombardment, took the fort, which was held by some troops of a Reserve Division (not a permanent garrison). The loss is a reflection on its defenders, not on its defences.

It is hoped at a later date to draw attention to the main features of the defence of a fortress by the Germans, for an account of the loss of Tsing-tau has just been published by a German admiral who took part in the defence.

* *La Defense de Fort de Vaux.*

† *La Guerre de la délivrance*, Vol. I, by General Cherfils, p. 155 *et seq.*

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THE GOLD MEDAL FOR THE CAPTURE OF FORT DETROIT AWARDED TO CAPT. M. C. DIXON, R.E.

By Col. H. BIDDULPH, C.M.G., D.S.O.

THE R.E. Institute has been fortunate enough to acquire by purchase a relic of the greatest rarity and historical interest, viz.: the Commanding Officer's Gold Medal for the capture of Fort Detroit, awarded to Captain Matthew Charles Dixon, R.E. The war of 1812–1814 is one of interest, as an example of the successful defence of an extended frontier by inferior forces.

On 19th June, 1812, the U.S. declared war on Great Britain, having already put in train its plans for the invasion of Canada. The American force detailed for the attack above Lake Erie was commanded by Brigadier-General W. Hull, who had served in the War of Independence; crossing the Detroit River he established himself on the Canadian side at Sandwich.

Meanwhile Major-General Isaac Brock, President of Upper Canada, had taken active steps with his inadequate forces for the defence of the frontier. Various skirmishes took place, unfavourable to the Americans, and before long a small British force crossed to the American side of the river cutting the American lines of communication. Their attempts to re-open their communications failed, and in consequence the American troops were compelled to re-cross to their own side at Fort Detroit. By this time General Brock, having completed urgent civil duties, hastened to take the field in person. The troops at his disposal consisted of 500 men of H.M. 41st Foot, 400 militia and some 600 Indians, with a few guns. Capt. Dixon, R.E., was his engineer officer and superintended the construction of batteries near Sandwich to bombard Fort Detroit, on which they opened fire on 15th August. During that night and the next morning the British crossed the river and proceeded to the attack, the bombardment being continued meanwhile. When General Brock and his men were within a few hundred yards of the fort, Hull hoisted the white flag and surrendered with all his force, 2,500 in number. His command included the 4th Regiment U.S. Infantry, detachments of the 1st and 3rd Regiments, two troops of cavalry, one company of artillery engineers, four regiments of militia, with 39 cannon, all of which fell into the hands of the British with large quantities of arms, ammunition and stores, and also a brig of 200 tons. The British casualties on this day, 16th August, 1812, were *nil*. For his eminent services General Brock was nominated a Knight of the Bath on 10th October, 1812, but did not live to learn of this recognition, for he fell while leading his men at Queenston, on 13th October, 1812, when the American General, Wadsworth, with

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over 900 men surrendered after a hot engagement. Captain Dixon's part in these operations is told in the following extracts :—

(*a*) CAPTAIN J. B. GLEGG, A.A.G., TO COLONEL THOS. TALBOT.

YORK, *12th March*, 1812.

" * * * Captain Dixon is gone to Amherstburg to superintend the works at that post and St. Joseph's. In a few weeks we shall commence our grand plan of fortifications for this post, and the marine department will not be idle * * * "

(*b*) H.E. LT.-GENERAL SIR GEO. PREVOST, GOVERNOR-GENERAL, TO MAJOR-GENERAL ISAAC BROCK.

QUEBEC, *July 31st*, 1812.

" * * * The report transmitted by Capt. Dixon of the Royal Engineers to Lt.-Colonel Bruyères (C.R.E.) of the state of defence in which he had placed Fort Amherstburg, together with the description of the troops allotted for its defence, give me a foreboding that the result of General Hull's attempt upon that fort will terminate honourably to our arms. * * * "

(*c*) DISTRICT GENERAL ORDERS, H.Q. FORT AMHERSTBURG.

August 14th, 1812.

" * * * Captains * * * and Captain Dixon, Royal Engineers, are appointed to the rank of Major so long as the local service on which they are employed continues. * * * "

(*d*) DESPATCH OF MAJOR-GENERAL I. BROCK

H.Q. DETROIT, *August 17th*, 1812.

Sir, * * * Batteries had likewise been commenced opposite Fort Detroit for one 18pr., two 12-inch and two 5½-inch mortars, all of which opened on the evening of the 15th (having previously summoned Brigadier-General Hull to surrender) and although opposed by a well-directed fire from seven 24-pr., such was their construction under the able directing of Captain Dixon of the Royal Engineers that no injury was sustained from its effect * * * "

ISAAC BROCK, *Major-General.*

H.E. LT.-GENERAL SIR GEO. PREVOST, BART.

The prize money for Detroit varied from 1 share for a private to 80 shares for a general ; each share being £3 currency. Capt. Dixon's further services in the war were at Sandusky, when the British under General Procter made an unsuccessful attack on Fort Stephenson, 2nd August, 1813, on which occasion Dixon was wounded ; and in the retreat to Moraviantown, when General Procter with a small force of about 1,000 all told, was defeated by an American force of over 4,000 men. (September–October, 1813). On this occasion Captain Dixon was taken prisoner. A short *résumé* of Dixon's services is as follows :—First commission, 2nd April, 1806 ; Canada, 1808–1815 ; West Indies, 1825–1827 ; Ceylon, 1835–1842 ; Canada, 1852 until his retirement in 1854, the intervals being home service or unemployment. He attained the rank of Major-General on 20th June, 1854, and died at Southampton on 30th Jan., 1860.

As a matter of interest two lists are appended : Appendix A

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giving the detail of the gold medals awarded for Detroit; and Appendix B giving a complete list of all engineer officers who received gold medals during the period 1806–1814. The first gold medal awarded to the army was that for Maida in 1806; and successive gold medals were authorized for the principal battles and sieges until 1814. On the enlargement of the Order of the Bath, into three classes, in January, 1815, the issue of gold medals ceased, as it was considered that the services of subordinate general officers, commanding officers, and senior staff officers could be rewarded adequately by the C.B. or K.C.B.

On 7th October, 1813 it was laid down that, owing to the increased number of medals, one medal only should be borne by each officer, and that successive battles and sieges should be commemorated by gold clasps. On an officer becoming entitled to a fourth mark of distinction, a gold cross was to be substituted, with the names of four battles or sieges inscribed on the four arms; subsequent distinctions being additional gold clasps. (The Duke of Wellington wore the gold cross with nine clasps).

No general or other officer was entitled to an award unless he had been personally and particularly engaged on the occasion, nor was he to be a candidate except upon the special selection and report of the commander of the forces upon the spot for conspicuous services.

Further, the Commander of the Forces was to restrict his choice to General Officers, Commanding Officers of brigades, Commanding Officers of artillery and engineers, Adjutant-General, Q.M. General; the Military Secretary, D.A.G., and D.Q.M.G. being field officers; the A.A.G. and A.Q.M.G. being field officers and being at the head of the staff with a detached corps or distinct division; Commanding Officers of battalions or corps equivalent and officers succeeding to the command during the engagement owing to casualties.

These regulations account for the distinction and the rarity of the Gold Medal.

APPENDIX A.

Officers Awarded the Gold Medal for Detroit.

The Issue was Authorized on 28th January, 1814.

*Major-General Isaac Brock, G.O.C. (Large Gold Medal).
Colonel Matt. Elliott, commanding Battalion of Canadian Militia.
Lt.-Colonel Robt. Nichol, Q.M.G. Militia in Upper Canada.
Lt.-Colonel Thos. Bligh St. George, Inspecting Field Officer.
*Lt.-Colonel Jno. M'Donnell, Military Secretary.
Major Jno. B. Glegg, A.A.G.
Major Peter Latouche Chambers, 41st Foot.
Capt. Matt. Chas. Dixon, R.E.
Capt. Joseph Tallon, 41st Foot.
Lieut. Felix Troughton, R.A.

* Major-General Brock was nominated on 10th October, 1812, K.B. for his services at Detroit, but fell in action on 13th October, 1812, at Queenston with Lt.-Colonel Jno. M'Donnell (Attorney-General of the Province) who acted as his Military Secretary.

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APPENDIX B.

ENGINEER OFFICERS AWARDED GOLD CROSSES OR MEDALS, 1806–1814.

Name, and Rank in Campaign.	*Battles and Sieges earning the Awards.*
ROYAL ENGINEERS.	
*Lt.-Colonel Sir Richard Fletcher, Bt. (6 awards)	Talavera, Busaco, Ciudad Rodrigo, Badajoz, Vittoria, San Sebastian.
Lt.-Colonel John Fox Burgoyne (5 awards)	Badajoz, Salamanca, Vittoria, San Sebastian, Nive.
Lt.-Colonel Henry Goldfinch (4 awards)	Vittoria, Nive, Orthes, Toulouse.
Lt.-Colonel Howard Elphinstone (3 awards)	Roleia, Nivelle, Nive.
Brig.-General Sir Chas. Shipley, Kt. (2 awards, *Large* Gold Medal and Clasp)	Martinique, Guadeloupe.
Major Chas. Felix Smith (2 awards)	Vittoria, San Sebastian.
Lt.-Colonel Steph. Remnant Chapman (1 award)	Busaco.
Lt.-Colonel Jno. Thos. Jones (1 award	Badajoz.
Major Chas. Grene Ellicombe (1 award)	San Sebastian.
Major Jno. Squire (1 award)	Badajoz.
Capt. Geo. Landmann (1 award)	Vimiera.
Capt. Matt. Chas. Dixon (1 award)	Detroit.
Capt. Geo. H. Henderson (1 award)	San Sebastian.
MADRAS ENGINEERS.	
Lt.-Colonel Colin Mackenzie (1 award)	Java.
INFANTRY, ATTACHED TO R.E.	
Major Alex. Thompson, Assistant Engineer	San Sebastian.

* Lt.-Col. Sir R. Fletcher was killed at the Siege of San Sebastian.

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THE GOLD MEDAL FOR THE CAPTURE OF FORT DETROIT AWARDED TO CAPT. M. C. DIXON, R.E.

The Riband of the Medal is red centre ($1\frac{5}{8}$") with blue edges ($\frac{1}{4}$"), similar to that issued with the Waterloo Medal.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 8.—" *Politics and War—the past and the future.*"—Lt.-Gen. von Altrock quotes Clausewitz's saying, " War is merely pursuit of policy by other means," and says that whereas Germany always understood these " other means " to imply the destruction of the enemy's armed forces, England went and goes much further ; she aims at the destruction of Germany. It was through England that the hunger blockade was instituted and the war turned into a process of attrition of men and material. German policy was half-hearted and her strategy spasmodic. Her enemies, however, followed the example of ancient Rome and, finding themselves in danger, placed themselves unreservedly under the command of dictators ; Clemenceau in France, Lloyd George in England, and Wilson in America. Results show they did right, but it is questionable whether in the Germany of the future, the land of full political individuality, where everyone from the Chancellor to the ploughboy thinks he knows far better than the man on the spot, will ever produce or put up with such a dictatorship. The day of reckoning is far distant ; there can be no real hope of any essential amendment of the treaty and now and always the hunger blockade can be used as a whip to bring Germany into line. Nevertheless an industrious people cannot always be held down. Let Germany but organize and inspire those inexhaustible resources that lie in Eastern Europe, and within the next 50 years she will be able to stand free from England's bonds. Let her make away with Internationalism and Universal Brotherhood and adopt the true socialism which makes Germans hold together and gladly give all for the State. Then will the millions of Germans be able to pass from universal misery to the day of reckoning which will enable them to say once more " Lieb Vaterland, magst ruhig sein ! "

Orders for the Reduction of the Army.—As already notified the Reichswehr will, after 31st December, 1920, consist of seven divisions, corresponding to seven districts, and three cavalry divisions. The divisions will be constituted on lines very similar to those evolved in the war, but without heavy artillery. Each infantry and artillery regiment will have a depôt battalion or battery included in the division. Up to 31st December, 1920, an additional 50,000 men have been authorized. These, who at present are distributed partly among divisions and partly in three extra brigades, are being disbanded and on 31st December, 1920, a considerable re-arrangement will come into force in order to get troops into their correct districts ; Berlin in particular will lose a large number of men.

The Break-down of Russian Railways.—It is estimated that whereas in April, 1919, the Bolshevists had 17 serviceable locomotives per 100 versts, in April, 1920, they had only 9. This is largely accounted for by the collapse of Denikin, after which many versts of railway but few engines came under their control.

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Dangers of Unions in the Army.—The *M.W.B.*, which has hitherto been the great supporter and unofficial registrar of regimental unions and various similar associations, now publishes a warning as to the "Dangers of Unions in the Army." After pointing out where these lie, it adds that in the new army every soldier must feel that he can rely on the Government and the Reichstag to look after his true interests. The formation of protective leagues, guilds, and economic organizations in connection with the army must be forbidden. Article 177 of the Treaty definitely prohibits any such associations in connection with military matters, and para. 32 of the Reichswehr law has been drawn up to carry this article into effect. Members of the Reichswehr still retain, however, the right to associate for non-political objects.

Shortage of Houses.—The use of vacated barracks is discussed, but as 40% of Germany's pre-war barracks lie in territory now no longer at her disposal and as the remaining 60% has to accommodate the much-married long-service Reichswehr man and has to fulfil many other uses that have arisen since the war, it is feared that very little relief can be expected from this source.

No. 9.—*Racial Impulse.*—Dr. Erich Ritter asks how it came about that Germany, the superior of her enemies physically, spiritually, and morally, came to be beaten. He finds the answer in a book recently published by an officer, who attributes all Germany's misfortunes to lack of "Racial Impulse." It appears that this is a quality which every race except the Teutonic possesses. The French-Swiss, Danish-Sleswiger and French-Alsatian sided vigorously with the Entente, but the Dutch, who are of Low-German origin, and the German-Swiss showed no inclination to emerge from their artificial frontiers. As for Germans in other lands, except for a few leading personalities, they fitted their politics to their frontiers. Among German working classes race feeling is entirely lacking, and they gladly side with their own classes in enemy countries against those of their own race who happen to be of the possessing or governing classes. There can be no hope for Germans till they cultivate a healthy selfishness and learn to regard every fellow countryman as a friend and every alien as a potential enemy.

Scandinavia and the General Situation.—This article points out the awkward position in which Scandinavia is placed. On the one hand the Entente demands assistance towards the blockade of Russia, and on the other imperialistic Soviet-Russia, headed off from the Black Sea outlet for her exports by the Entente, threatens to overwhelm her, *viâ* Finland, all the more willingly by reason of the hatred by which the blockade policy arouses. The article, which is from a Swedish source, is welcomed by the *M.W.B.* as showing, firstly, how correctly this journal has always estimated the Bolshevist danger, and, secondly, what a snare and delusion the League of Nations is to those who adhere to it.

No. 10.—*Sedan.*—The 50th anniversary of Sedan calls forth from Lt.-Gen. von Altrock the wish that the rebuilding of German power may one day give rise to a new Sedan which will make Germany free and strong.

The Miracle of the Marne, 1914.—Lt.-Col. Dieterich, who commanded an artillery brigade in the 2nd Army, contributes an account of his personal experiences. His guns took up a position behind the right of

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the 20th Division facing Allemant early in the morning of the 9th September. At noon he observed the German infantry had reached the French position at Allemant and the enemy's artillery was obviously withdrawing. German infantry could be seen in column of route on the south bank of the Petit Morin, everywhere the French were retreating in haste, and the victory of the left wing of the 2nd Army and the right of the 3rd seemed complete. He had been fighting since the 5th September and felt the then well-known satisfaction of hard won success. Then came the order, "At 4 o'clock the retreat will begin." They thought at first it was a joke and laughed at the orderly officer; sent the Adjutant to Divisional H.Q. to point out how well everything was going and to see if the order was correct. He came back with a glum face, having received the answer "Its just as well things are going well here, otherwise the right wing of the army could never get out of it. There things are very bad." Later he learnt that the Division had already remonstrated, without success, at Corps H.Q. He knew that the 10th Reserve Corps had had hard fighting, but has since been confidently assured by troops of this corps that they were well able to hang on. Had they been allowed to do so, and even if they had been pushed back to some extent, the advance of the left wing would have placed the 5th French Army and the English in a very critical position. However, he saw the long German columns halt and pile arms; after a time they set off again, but this time in the opposite direction, their lines of skirmishers forming a rear guard. No enemy followed them. French artillery fired for hours on to ground long evacuated by the Germans. One battery of 10th Artillery Regiment left its guns in position, the detachments joining the infantry and thinking it impossible to limber up in broad daylight. In the evening, when all the infantry had gone, the Adjutant took back the teams and brought away the guns absolutely unmolested by the enemy. The Saxons left behind them over 30 captured French guns. It was a victory if ever there was one. Dieterich declares that even if the 2nd Army had been beaten there was no need for the retreat of all the German armies, and that as a matter of fact the victory of the left was complete enough to outweigh any reverse on the right. The men could not understand why they had to retire and all thought it only for a time. It was not till the 11th that the French came cautiously into touch with them on the Marne near Epernay; on the evening of the same day the author followed the 12th Corps, in pouring rain, through the forest of Rheims. No one imagined what tragic consequences the Miracle of the Marne was to have.

Recruiting for the Russian Army.—In view of the many statements that the Bolshevists are receiving help in one way or another from Germany, the following note by the *M.W.B.*, which has always derided such statements, is interesting: "Attempts are said to be being made by the Russians to enlist members of the German Army under apparently favourable conditions. Particulars are lacking, but it is hardly necessary to point out to any servant of the German State that in the interests both of it and of themselves the most emphatic warning must be given against such recruiting."

Reconciliation.—It is noticeable that the *M.W.B.*, though quick to

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condemn any move in this direction on the part of the Germans, is not at all unwilling to receive word of such from the side of the Entente.

Salaries of Brain-workers.—Out of 233 non-established professors, only 13 have a total income of more than 10,000 marks and out of 487 established ones, 232 fall below this level (between £40 and £50 per annum at present exchange).

Tannenberg Festival.—Some 30,000 people assembled in Berlin to commemorate the anniversary of Tannenberg. *M.W.B.* much pleased with the enthusiasm aroused.

No. 11.—*Observations from the 2nd* (? *1st*) *Army Front during the Battle of the Marne*, 1914.—A subaltern of the reserve who served in the 9th Jäger Battalion in 1914 gives his experiences. He begins by stating that the numerous articles that have recently appeared dealing with the problem of the Marne leave little room for doubt that it was over-estimation of the danger caused by the penetration of the English into the gap between the First and Second Armies that brought about the decision to retreat. He hopes that some one on the staff of the Cavalry Corps whose duty it was to fill this gap, and under whom the other troops allotted for this purpose (Kraewel Brigade, 5th Division, etc.) were placed, will publish an account from their point of view. From his position in the front line with his battalion he declares that the drive of the English, at any rate on the 9th September, was not powerful enough to arouse any fears of a break-through, and in support of this contention he recounts as follows :—On the 5th September the 4th Jäger battalions of the Cavalry Corps reached Coulommiers and on the 6th had their first day of rest since 4th August, while their cyclist companies pushed on to near Maupertius and maintained touch with the English. On the 7th came the order to retreat, and early on the morning of the 8th they reached the high ground near Jouarre, where they bivouacked. Thus far they had been unmolested, but now there were a few skirmishes between rear and vanguards south of Jouarre. About noon they marched down the valley towards La Ferté and filed over the Marne and up the hills on the opposite side. The long columns of vehicles trailing over the single bridge could, he thinks, have been very roughly handled had the English been pressing hard on their rear, but, as it was, only a few shrapnel bursting high and harmless over the town gave any sign of their approach. The author was now ordered to take his platoon and hold the big railway bridge over the Marne near Chamigny " to the last man." This phrase was under the circumstances, quite incomprehensible to him, since the hestiating manner in which they were being followed led him to believe that the rearward move was merely a manœuvre to lead the enemy into a trap. So little seriously was the situation taken that on arrival at the bridge he allowed his men to bathe, half at a time, their first bath for 6 weeks, while overhead the artillery exchanged a few shots. The afternoon went quietly on ; towards evening the gun-fire in the direction of La Ferté increased somewhat and presently a heavy detonation signalled the demolition of the bridge there. Late in the evening the company commander on his right (4th Jäger) asked him to support him with connecting patrols along the bank because several English divisions were opposite and would probably try to force a crossing during the night. The author

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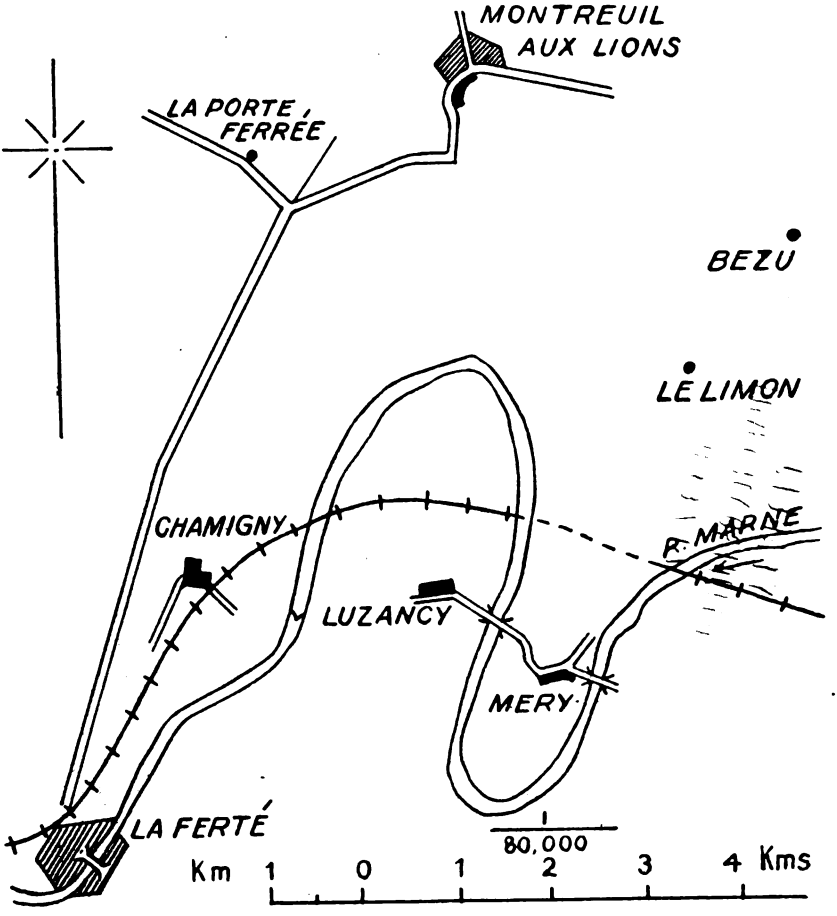
had seen nothing more than a few artillery observers at several kilometres distance. However, the night was absolutely undisturbed and the morning of the 9th was equally quiet, except for heavier artillery fire towards La Ferté, and so far as he could see not even a cavalry or infantry patrol approached the opposite bank. He therefore went for a tour round beyond his patrols, as far as the tunnel south of Courcelles, meeting on the way a patrol of the 2nd Dragoons, who told him an English battery was near Bucancy (? Luzancy). On returning to his platoon his attention was directed to an English battery immediately



above the tunnel, which was trying to conceal itself with straw. It was then past mid-day. The next thing he saw was a column of six English batteries followed by at least 12 companies in column of route marching north on the road from Mery to Bezu, near Limon, already north of the Marne; as the artillery could scarcely be leading he concluded that at least one regiment of infantry must already have passed unnoticed by him. According to von Bulow's book this must have been the left column of the middle English corps. He concludes that the main body of this corps cannot have been as far north as the Marne, as von Bulow states, by 10 a.m. on the 9th, but not till early in the afternoon.

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Still less do the results of his observations tally with von Bulow's times for the 3rd English (left flank) corps Towards 4 or 5 o'clock he saw English skirmishers feeling their way cautiously towards the section of the Marne held by his right-hand neighbour To his surprise they were only received with a little rifle fire, obviously from a patrol left behind, and even that soon ceased. As he afterwards learned, everybody on his right had already been ordered back on to the heights of the northern bank. The English crossed the Marne by the lock in single file and deployed from the lock house in the direction of the heights north-east of La Ferté. The English, therefore, were not across the Marne with the main body of the 3rd Corps at 10 a.m. on the 9th, but not till between 4 and 5 p.m. In order to prevent his platoon being captured, he withdrew now to the plateau to the north and saw, the time being about 6 p.m., the leading English firing line about a kilometer to the south-west. Subsequently he reached his battalion and marched with it *viâ* Coulombs to Gandelu which he reached on the 10th. Here his own and the 4th Jägers had a very unequal fight with a parallel-marching English column in the course of which both the Jäger battalions were practically wiped out. He remarks how much more to the point it would have been to have expended these fine battalions in the higher task of defending the Marne crossings, rather than to have them destroyed as they were, almost uselessly, while in retreat. He sums up as follows :—

(i).—The two left English corps did not reach the points indicated in the maps accompanying von Bulow's account, at 10 a.m. on the 9th, but not till six to nine hours later. How far the right corps had reached by that time he did not see for himself, but, as von Bulow says it was echelonned in rear of the others, it must have been still later.

(ii).—In his opinion such war-tried crack battalions as the Jäger were admirably suited for such a task as the defence of the Marne, and could have put up a much longer stand there, particularly considering the lack of offensive spirit and sluggishness of the enemy. He and other front-line fighters will never be able to understand why after six weeks of the greatest exertions in fighting and marching they were not asked on this occasion to give their utmost until all their successes had already been sacrificed.

NOTE :—As regards (i.) above, the author appears to have drawn wider conclusions than his comparatively restricted opportunites for observation justify. We know from other accounts that von Kraewel's brigade was heavily engaged by 9 a.m. on the 9th at Montreuil-aux-Lions, having been under artillery fire for over an hour before that. It is noticeable that the author makes no mention of this fighting, but sound travels very curiously in that country, and he very likely never heard a shot.

The first meeting of the Army Advisory Council did not, it appears, pass off very smoothly and the extreme left Press did not fail to utilise the chance for an attack on the army chiefs. The *M.W.B.* recapitulates the objects of this Council, the chief of which is to establish confidence, and to convince the army that its interests are best represented by superiors. The Council is a concession to the now almost universal principle of class representation, and it is hoped that this new institution will develop in a way that will work no harm to the internal strength of the troops.

L. CHENEVIX-TRENCH, *Maj., R.E.*

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REVUE MILITAIRE GÉNÉRALE.

May, 1920.

Variations in the German Plan of Campaign between 1871 *and* 1914.—A study by Lt.Col. de Thomasson of a book called "Der Generalstab," by General von Kuhl, for 22 years attached to the General Staff in Berlin, and Chief Staff Officer to Kluck's Army in 1914, and of a criticism of it by Count Max Montgelas, published in the *Berliner Tageblatt*. Kuhl affirms that after the war of 1870, and before the Congress of Berlin, Moltke was studying a war against France and Russia combined. Moltke first advised an offensive against France and a defensive against Russia, but on the reorganization of the French Army and commencement of the system of fortifications of General Séré de Rivière, he saw that a rapid decision on the west front was no longer possible. In 1879, as soon as the Austro-German alliance was concluded, he induced the Emperor to adopt an offensive against Russia, and a defensive against France. Waldersee, who worked with Moltke from 1882 and succeeded him in 1888, agreed with this policy with certain reservations. Schlieffen, Chief of the General Staff from 1891, at first followed his predecessors' steps, but as armies increased in size and required larger areas in which to manœuvre, it became evident that Moltke's plan must be revised. Schlieffen also partook of Waldersee's doubts in regard to Poland, and resolved to return to Moltke's first plan, but in fear of the French fortified front in Lorraine saw no other solution than the invasion of France through Belgium. As years went on Schlieffen entirely renounced any idea of a frontal attack, and strengthened more and more the German right, and, after the Russo-Japanese War had removed the menace to his rear, detailed for the western front almost the whole of his first-line troops, and even reduced to a minimum the containing force left in Alsace-Lorraine. In 1906 Schlieffen was replaced by "le petit Moltke," a mere figure-head, and the General Staff, considering that to abandon almost the whole of Alsace-Lorraine to the French would have a bad effect, doubled the small field army in that area, and in view of Russia's recovery after the Russo-Japanese war sent 4 more *corps d'armées* to the eastern front, leaving only 27 instead of 35 for the great outflanking movement through Belgium and the north of France. Kuhl considers that it would have been better to mass on the right wing all the troops possible, and his remarks are sound. It is odd, however, that no German writer has brought out the fundamental inferiority of Schlieffen's plan, and of his plan as modified by the little Moltke to that of the great Moltke. The latter made the right his pivot, and the left his enveloping flank, to drive the French armies back on Belgium, whereas the former could only drive them back into France where they might hold out indefinitely if beaten in the first battle. Montgelas, wise after the event, has a great deal of advice to offer, but allows that he has mainly followed Schlieffen's plan, and that the dispositions he proposes might not have proved a striking success. At any rate his ideas are of interest, but hardly bear critical examination. The great lesson which emerges from the study of all these German plans is the immense value of our fortified front in Lorraine.

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THE SYRIAN QUESTION.

An article by Major Sarron written to place concisely before the French public the military and political questions involved by the conquest of Syria. It relates the main military operations, the political state of the country before, during and after the war, and sketches the administrative work to be carried out under the French mandate. The article, though written from the French point of view, is interesting and instructive, bearing as it does on British interests in the country. After describing the state of the country at the time when General Gourand was dispatched to Syria, Major Sarron writes :—It is therefore an urgent matter to remedy this critical situation, or Bolshevism, already rampant in the Caucasus, may obtain a hold in Syria. From experience gained during 15 years' residence in the East the following programme is suggested : 1st, to occupy the whole country over which the French mandate is to be exercised ; 2nd, to proceed immediately with the administrative organization ; and 3rd, to restore and develop the economic position. The zone to occupy is that recognized by the 1916 agreement from Mosul to the Mediterranean, and from the Taurus to Hauran inclusive, together with the districts of Aleppo and Damascus. To allow the Sherif to administer Eastern Syria is to tolerate anarchy and open the whole country to Bolshevism, including the coastal region occupied by the French troops, and even the neighbouring British possessions of Egypt and India. For divers reasons the inhabitants, Christian and Moslem, wish France to occupy the whole country, and the English colonial agents should have the same desire if they have any conception of their real interests. The occupation would not demand more troops than are now in the country, for the inhabitants are friendly to France. The administrative reorganization presents no difficulty. It would suffice to perfect the Ottoman administration, the laws and regulations of which were derived from French sources, and are adapted to the needs of the country. The retreating Turks removed the greater part of their own functionaries, and the gendarmerie is particularly disorganized but enough Syrian officials, both Christian and Moslem, still remain to carry on the various services, if competent supervision is arranged for. A native administration is necessary, and is desired by the people ; the control of it should be entrusted to French officials who know the country. The boundaries of some of the administrative sub-divisions, somewhat arbitrarily traced by the Turks, require modification. Over the sub-divisions a general council should be instituted, presided over by the Governor-General or High Commissioner, whichever is appointed by the French government. This council could be composed of one or more delegates from each province, and of a ministerial representative. The ministries necessary would be Home Affairs, Justice, Finance, Public Works, Trades, Police, etc., and ministers should be Frenchmen of acknowledged repute. A mixed council of this nature would result in the greatest benefit not only to Syria but to France, and would meet the aspirations of the Syrians. The following services in order of urgency require attention : 1st, the gendarmerie should be remodelled on the lines introduced by France before the war ; 2nd, the Justiciary demands certain modifications to establish absolute equality

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for Christian and Moslem alike; 3rd, the existing financial laws should be applied impartially, the imposition of taxes must be regulated, and their systematic collection arranged for; 4th, the police force of the towns requires complete reorganization; and 5th, the administration of the Customs, Public Works and Agriculture must be rescued from their present state of neglect. Under Turkish misrule the development of Syria made no great strides, while in Roman times the country was the granary of the Empire. Still the trade was considerable until interrupted by the war, and it is incumbent on France to hasten the ratification of peace with Turkey. Then to develop the country economically the following must be put in hand at once: (1) a system of roads and railways to complete those existing and make Syria the channel for the commerce of Central Asia through Persia to the Mediterranean; (2) agriculture and re-afforestation; (3) modern institutions for the encouragement of trade must be introduced, such as commercial schools, chambers of commerce, etc., and coastal navigation must be developed; (4) an official recognized monetary system must be established. The Ottoman Bank could help in this pending the finding of a definite solution of the difficulty. Above all the good offices must be secured of competent administators who understand the East and especially the Turkish Empire.

A. R. REYNOLDS.

REVUE MILITAIRE SUISSE.

No. 8. *August*, 1920.

FROM CHARLEROI TO THE MARNE.

The article by Colonel Poudret on the above subject begun in the July number of the *Revue* is concluded in the number under notice. The enquiry as to who it was that should primarily be held responsible for the orders for retreat from the Marne given to the German Armies in September, 1914, is pursued. It is pointed out that the situation of the German *right wing* was certainly most unfavourable at the time; but elsewhere on the German battle front the situation was no better. Von Kluck may reasonably be held responsible for the condition of affairs that existed on the extreme right of the German line, but for the general situation the blame lies on other shoulders. Von Kluck's appreciation of the local situation, it is pointed out, appears to have been faulty in many particulars, and he seems to have acted too impetuously and to too great an extent on his own responsibility. The German army system in which every effort was made to develop initiative in the higher leaders was thus bearing fruit of a kind little expected of it. Admitting that von Kluck's handling of his command was not as skilful as it might have been, nevertheless, Colonel Poudret thinks, the situation was aggravated by the measures adopted by the German G.H.Q. It was essential to success that the German right wing should possess a superiority in numbers, in order that it might remain the deciding factor on the Western Front. In the original article, it is shown that von Kluck had just cause for complaint against his G.H.Q.; for the German right wing was weakened just at the time that it should

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have been strengthened. The appreciation of the general situation on the part of the German G.H.Q. was as faulty as that in relation to the local situation on the right wing by von Kluck. The German High Command persuaded itself that its most dangerous foe had been beaten, and that the annihilation of the Entente Armies on the Western Front was but a matter of time ; one, moreover, requiring but relatively weak forces. Hence the decision to reinforce the German Eastern Front by withdrawing forces from the Western Front : the Tannenberg Victory, it follows, cost the German nation very dear. The visit of Colonel Hentsch, the *liaison* officer sent from the German G.H.Q., to von Kluck's headquarters is dealt with at some length. It is suggested that Hentsch formed a wrong impression from what he had learned whilst at von Bulow's headquarters. Attention is directed to the remarkable circumstance that, on visiting the headquarters of the German I. Army, Hentsch only saw General von Kuhl, von Kluck's Chief of Staff, in spite of the fact that the commander of the I. Army was close at hand at the time ; von Kluck does not even seem to have been informed of Hentsch's visit until after the latter's departure. The interview between von Kuhl and Hentsch acquires importance from the fact that accounts of what passed at this interview, as now given by the two officers, differ in material points. The question is whether Hentsch issued orders, on behalf of the German G.H.Q., for the retreat of the I. Army, or whether he merely confirmed, on behalf of G.H.Q., the measures already adopted at I. Army headquarters. It is on record that, after Hentsch's departure, von Kluck learned from his Chief of Staff of the visit of the G.H.Q. *liaison* officer, and thereupon issued an order to the troops under his command. In the circumstances, the terms of this order are, from a historical point of view, exceedingly important. In this order it is stated that the position in which the II. Army was then placed necessitated a retreat. Von Kluck next proceeds, "*by order of the High Command* the I. Army will retire in the general direction of Soissons in order to cover the right of German line, etc., etc., etc." Hence, it seems unlikely that the decision to retire originated with him. Whatever blame attaches to von Bulow, the conclusions appear to be, that the responsibility for the steps taken during the fateful days of September, 1914, must be shared by the German G.H.Q., which was further guilty of a most serious error in judgment in establishing itself so far back from the battle front as Luxemburg, where it was completely out of touch with the events in progress and therefore could not intervene in time, had it the capacity to do so, either to remedy the faulty handling of the troops by the Army Commanders, or to take advantage of the developments in progress for the purpose of recasting the strategic plan to meet the changing conditions.

REORGANIZATION OF THE INFANTRY.

The article on the above subject by Major Schmidt begun in the *Revue* for May, 1920, is continued in the number under notice. The question of the organization of the battalion is dealt with ; the battalion organization is considered entirely from the point of view of battle requirements.

W. A. J. O'MEARA.

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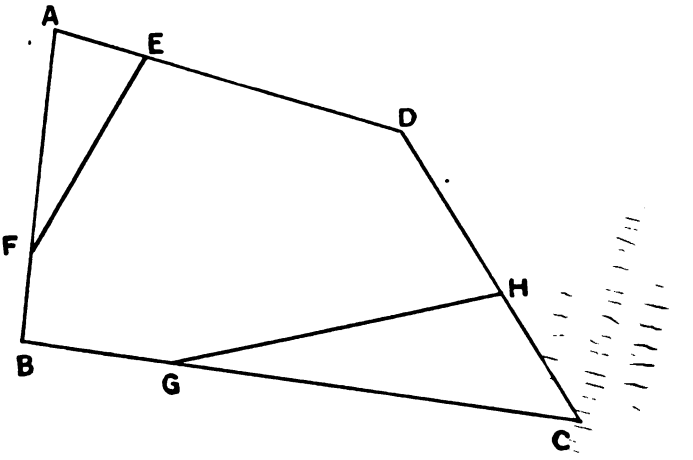
PROBLEMS.

PROBLEM 16 (Solution).

Four rods are freely jointed at ABCD, and lie on a smooth horizontal plane. EFGH are the centres of the rods, and the points EF and GH are joined by bars smoothly jointed at EFGH. If the system is in equilibrium and if the tension in EF be P, find the stress in GH.



To make the solution more general I have supposed EFGH to be any points.

Suppose EF and GH to be shortened by small quantities of the 1st order d. EF and d. GH.

Then by the principle of virtual work

$$P \,.\, d \,.\, EF + Q \,.\, d \,.\, GH = 0 \qquad Q = \text{stress in GH.}$$

AB, AD, BC, DC become very slightly bent, but their alteration in length is by a well known principle of geometry a small quantity of the 3rd order.

Hence the lengths of AB, AD, etc., may be considered as constant.

$$\cos A = \frac{AE^2 + AF^2 - EF^2}{2 \,.\, AE \,.\, AF} = \frac{AD^2 + AB^2 - BD^2}{2AD \,.\, AB}$$

$$\therefore \qquad \sin A \,.\, d \,.\, A = \frac{EF \,.\, d \,.\, EF}{AE \,.\, AF} = \frac{BD \,.\, d \,.\, BD}{AD \,.\, AB} = \frac{K}{AD \,.\, AB}$$

where $K \equiv BD \,.\, d \,.\, BD$.

$$\therefore \qquad d \,.\, EF = \frac{AE \,.\, AF}{AD \,.\, AB} \times \frac{K}{EF} \,.$$

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Similarly $$d \cdot GH = \frac{CG \cdot CH}{CD \cdot CB} \times \frac{K}{GH}.$$

$\therefore$ Principle of virtual work gives

$$\frac{P}{EF} \cdot \frac{AE \cdot AF}{AD \cdot AB} + \frac{Q}{GH} \cdot \frac{CG \cdot CH}{CD \cdot CB} = 0.$$

Q is opposite in sign to P and if E, F, G, H, are the centres of the rods, $P + Q = 0$.

PROBLEM 17 (Solution).

Find the equation of the directrix of the parabola $x = at^2 + 2bt$, $y = At^2 + 2Bt$ where a b A B are constants.

The equations to the tangents at t_1 and t_2 are

$$y - At_1^2 - 2Bt_1 = \frac{At_1 + B}{at_1 + b}(x - at_1^2 - 2bt_1)$$ and a similar expression in t_2

which reduce to

$$y(at_1 + b) - x(At_1 + B) + t_1^2(Ab - aB) = 0 \quad \ldots\ldots\ldots\ldots (1).$$

and $$y(at_2 + b) - x(At_2 + B) + t_2^2(Ab - aB) = 0 \quad \ldots\ldots\ldots\ldots (2).$$

Now the directrix is the locus of intersection of perpendicular tangents.

The condition that 1 and 2 are perpendicular is

$$t_1 t_2 (A^2 + a^2) + (t_1 + t_2)(AB + ab) + B^2 + b^2 = 0 \quad \ldots\ldots\ldots\ldots (3).$$

The eliminant of 1, 2, 3 is the directrix.

Now for any given values of x . y . $t_1 t_2$ are the roots of

$$t^2(Ab - aB) - t(Ax - ay) + by - xB = 0,$$

from which $t_1 + t_2$ and $t_1 t_2$ can be found.

Hence the equation of the directrix is

$$(A^2 + a^2)(by - xB) + (AB + ab)(Ax - ay) + (B^2 + b^2)(Ab - aB) = 0.$$

PROBLEM 19.

Show that the nine point circles of the triangles formed from any 4 points by taking them 3 at a time meet in a point.

PROBLEM 20.

If the straight line $lx + my + n = 0$, meet the conic

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$$

in the points P and Q, find the equation of the pair of lines HP, HQ, the co-ords of H being $x^1 y^1$.

J. M. WADE, *Lt.-Col.*

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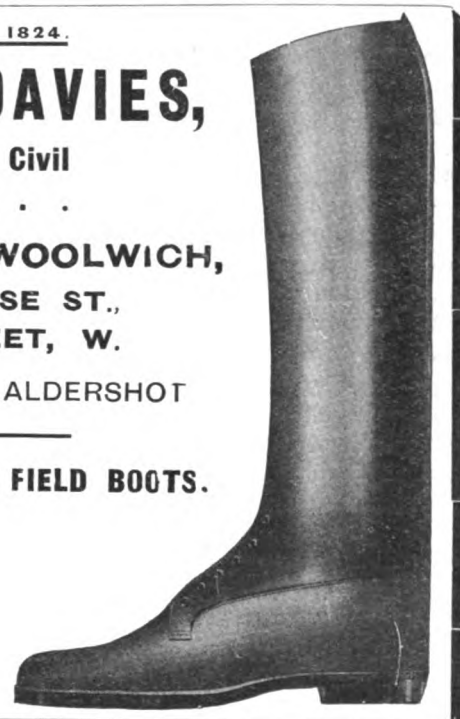

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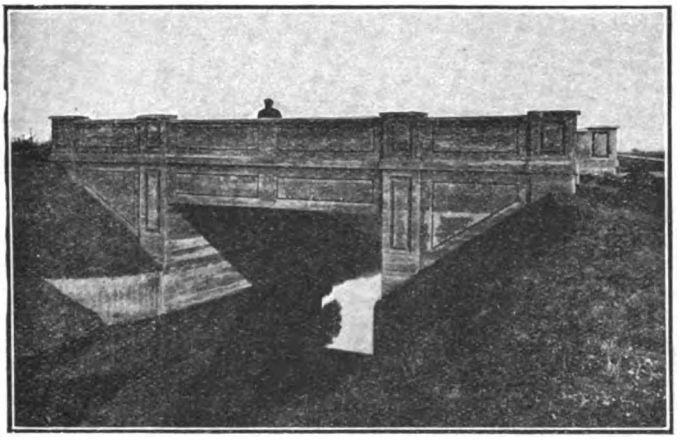

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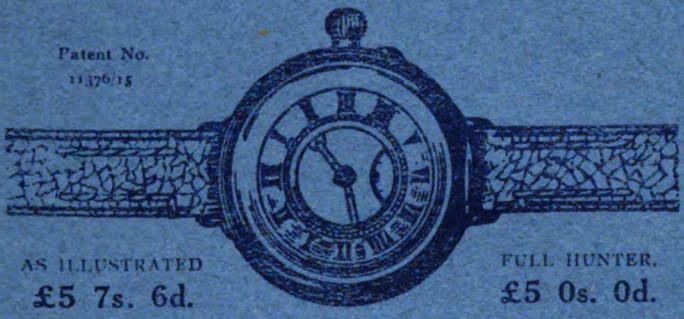

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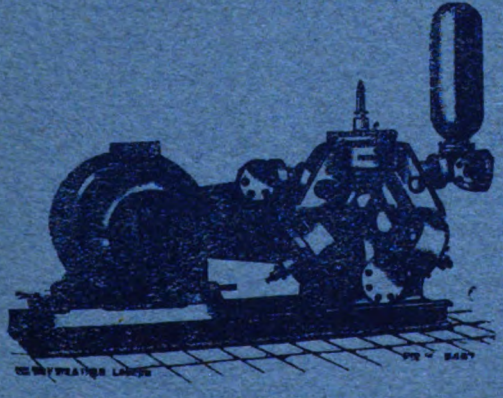

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